Laboratorio per lo Studio degli Effetti delle Radiazioni sui Materiali per lo Spazio
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INFN ROMA - CARSO

ENVIRONMENTAL TEST REPORT

ENVRPT_ST_TB_11JULY07.doc
date: July 11, 2007
Prot.:

signature

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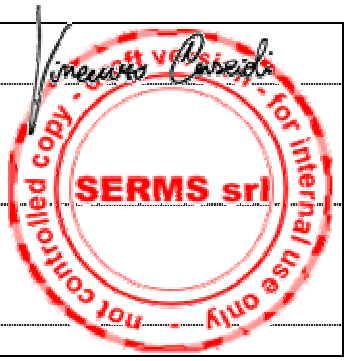
test report controlled by:	11/07/07	Ing. Stefano Lucidi *QA manager*	
approved by:	11/07/07	Dott.sa. B.Bertucci *Test Responsible*	



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date	change description	Revision
11/07/2007	first issue	A01

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TEST REPORT DESCRIPTION

This document is generated by the S.E.R.M.S. Laboratory and reports on the setup, the operation and the results of the test performed on the customer Device Under Test (D.U.T.); several sections compose this report: all of them have been integrated and adapted to the specific tests performed on the D.U.T.

CONTENTS

GENERAL INFORMATION

Job Number:

kdsjcfki

Test performed on:

AMICA Star Tracker (AST) - QM Model

Contractor:

INFN Roma – CARSO Trieste

Contractor responsible:

P. Trampus (CARSO Trieste)
C. Gargiulo (INFN-Roma)

Test responsible:

Three different subjects - CARSO, INFN-Roma and S.E.R.M.S.- have participated to this test. The applicable procedure has been written by INFN-Roma (C.Gargiulo) **Document No. AMS_02_AST_050106_rev2.**

Roles and responsibilities of the participating subjects are defined as follow:

- Test conduction has been responsibility of INFN-Roma.
  INFN-Roma personnel units at SERMS have contributed to the setup and disassembly phases, verifying thermal sensor locations and failure. They have the responsibility to issue procedure variation sheet (PVS).

- AST electronics switch-on/switch-off operations, monitoring and functional tests have been performed by CARSO personnel units. Recorded data from AST electronics functional test are under responsibility of CARSO.

- SERMS has been responsible for the test facility and the measurement hardware (thermal vacuum chamber, thermal sensors, pressure sensors, data acquisition chain).

- SERMS has been responsible of the environmental parameters and AST electronics temperature measurements along the whole test. Recorded data have been handled only by SERMS qualified personnel. They regularly monitored the test execution.

The SERMS project manager responsible for the test has been Ing. Vincenzo Cascioli.

APPLICABLE LAWS AND RULES

CUSTOMER TEST PROCEDURE

AMS_02 STAR TRACKER - THERMAL BALANCE / THERMAL VACUUM TEST PLAN
Document No. AMS_02_AST_050106_rev2, 06/03/06 and subsequent PVSs

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S.E.R.M.S Lab. - INTERNAL TEST PROCEDURE
09-PT-TVM-A01-26APR2K6.doc
THERMOVACUUM TEST PROCEDURE

D.L. 19 settembre 1994, n.626
Attuazione delle direttive 89/391/CEE, 89/654/CEE, 89/655/CEE, 89/656/CEE, 90/269/CEE, 90/270/CEE, 90/394/CEE e 90/679/CEE riguardanti il miglioramento della sicurezza e della salute dei lavoratori sul luogo di lavoro, e successive modifiche;

MIL-HDBK-831 23 Aprii 1999
Preparation of Test Reports (guidance only);

UNI –10653 – November 1997
Quality product technical documentation (guidance only) ;

UNI CEI EN45001
general criterion for test laboratory operation;

UNI CEI 70001
norm certificate test laboratory terms and definitions;

UNI CEI 70011
guide for test result presentation;

SERMS FACILITY - QUALITY ASSURANCE INFORMATION

EQUIPMENT	MANUFACTURER	P/N	S/N	ACCURACY	NEXT CAL DATE	REMARKS
TV chamber with pressure measurement and temperature acquisition system	Angelantoni	HVT-2000 MC	10107	NA	Conformance certificate (first installation) is dated 12/01/2007	Detailed technical informations will be provided by the Facility.
THERMAL RIBBONS	MINCO	S651		Class B tolerance	13/11/2006	None
Pressure sensor	LEYBOLD	ITR090 – No.12090	Fabrication number: 2809	±15% for reading in the range of 1 x 10^{-8} … 1 x 10^{-2} mbar after 5 min. of stabilization	13/11/2006	None
THERMAL SENSOR – thin film elements	MINCO	S245PD12	NA	100Ω ±0,12 %	28/02/2007	None

EQUIPMENT	MANUFACTURER	P/N	S/N	ACCURACY	NEXT CAL DATE	REMARKS
STRAIN GAGES 0°-90° T rosette	HBM	1-XY31-3/120	Lot A383/21 Batch 812023909	120Ω ±0,3 %	Purchase date 22/02/2006	None
STRAIN GAGES	HBM	1-LY19-6/120	Lot A222/01 Batch 867461/00	120Ω ±0,35 %	Purchase date 25/11/2005	None
DAQ	NATIONAL INSTRUMENTS	6036E	11DAA16	INPUT 16 bit 200kS/sec ±0,05 to ± 10 V	6/04/2007	None
Heaters	MINCO	HK5165R52.3L12	NA	NA	28/02/2007	Visual inspection
Heaters	MINCO	HK5167R264.0L12	NA	NA	28/02/2007	Visual inspection
Temperature controller	WATLOW	PDD1-CCCC-1AAA	S/N 000897 DC 0607	±0.1 percent of span, ±1°C at the calibrated ambient temperature	1/03/2007	None

EQUIPMENT	MANUFACTURER	P/N	S/N	ACCURACY	NEXT CAL DATE	REMARKS
Temperature controller	WATLOW	SD31-HCAA-AA0R	S/N 009222 DC 0337	±0.1 percent of span, ±1°C at the calibrated ambient temperature	1/03/2007	None
Feed troughs plugs	POSITRONICS			NA	10/01/2007	Visual inspection
Flat Cable	RS			NA	15/03/2007	Visual inspection

Thermal sensors (MINCO S245PD12 and S651) were fixed with Aluminium tape: Cho-Foil®, made by Chomerics.

Strain Gages (HBM 1-XY31-3/120) were fixed with epoxy paste adhesive: Hysol® EA 9394, made by Henkel.

TEST SUMMARY

The actual procedure adopted in the ***thermal balance test*** is schematically presented in figure 1.

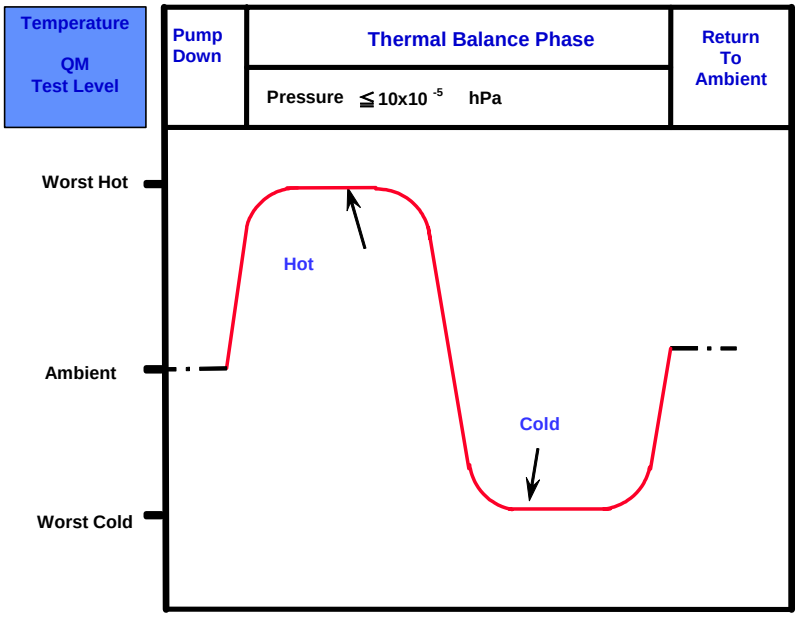


FIGURE 1 – TEST TEMPERATURE PROFILE.

It derives from:

1. the approved reference profile on the thermal balance test plan**:** AMS_02_AST_050106_rev2;
2. the PVS issued by the test conductor during the test ;

The profile temperature values are listed in the following table.

Interfaces	Worst case HOT	Worst case COLD
Baffle (radiative)	76°C	-65°C
TTCS (conductive)	15°C	-5°C
Tracker (conductive)	28°C	-10°C

It derives from the approved reference profile on the customer procedure: Document No. AMS_02_AST_050106_rev2, 06/03/06

TEST RESULTS

The AST qualification model has been tested at S.E.R.M.S. in the Thermal Vacuum Chamber (TVC) during the period July 7th – 10th 2006 (***thermal balance test***).

The ***thermal balance test*** has been performed according to the test profile shown in the previous section of this report under the continuous conduction of a customer representative (CARSO).
AST experts from CARSO have attended the test and operated the AST during the switch-on/switch-off and functional test phases. They had also attended positioning, calibration and measurement of the lasers.

No malfunctioning has been observed in the S.E.R.M.S equipment for temperature acquisition: the environmental parameters in the TVC matched the customer requests and were continuously recorded.

Some malfunctioning has been observed in the S.E.R.M.S equipment for strain acquisition (see Remark #1): the strain parameters have not been continuously recorded. Nevertheless the strain parameters have been acquired in the relevant phases (at the end of worst cases stabilization).

The AST temperatures have been continuously monitored in 38 locations and their values recorded during the whole test period. The AST deformations have been monitored in 14 locations (see Remark #1). The complete set of recorded data can be provided on customer request. In this report will be summarized only the most significant test data.

All the commitments of S.E.R.M.S. with the customer have been fulfilled and the test can be declared successfully completed for what concerns the items under S.E.R.M.S. responsibility.

The logbook and all functional test results are available as paper copy:
“Star_Tracker_TV_tets_Plan_050106 - APPENDIX 2 - THERMAL VACUUM BALANCE AND SUN IN THE LENS test procedure”

REMARKS

REMARK# 1

Deformation measurements on the AST were not recorded during three phases of the test (see FIGURE 51):

- Worst Case Hot (during a five hours period);
- transient before the Worst Case Cold (during a nine hours period);
- Worst Case Cold (during a nine hours period).

This interruptions was due to three errors of the data acquisition system. The environmental parameters control, and their recording, have not been affected by this event, because:

- the deformation values have been acquired in the relevant phases (at the end of worst cases stabilization)
- the deformation values were the same after and before the interruption period (Worst Case Hot and Cold stabilizations) and linear in the transient before the Worst Case Cold
- the strain sensors calibration (performed at the beginning of the test) was not lost during the data acquisition interruption: the calibration parameters have been stored at the beginning and they were the same at the end of the test.

REMARK# 2

The strain sensors calibration (performed at the beginning of the test) has not been performed at uniform temperature on the strain gage sensors (22 °C), but in the temperature range 23°C - 25°C.

REMARK# 3

The following strain gage sensor channels data:

- strain gage 1 - direction 0°
- strain gage 1 - direction 90°
- strain gage 5 - direction 90°
- strain gage 7 - direction 90°
- strain gage 14

have to be considered not valid for the high thickness of the glue used to fix them on the AST composite structure.

REMARK# 4

Some variations have been done regarding the position of the MLI.

- As foreseen in the customer procedure: the MLI should wrap separately the CTA (Copper Thermal Arm) bar, fixture and AST;
  As it was during the test: the MLI wrapped both CTA (Copper Thermal Arm) bar, fixture and AST to avoid Pt100 wires pulling and because there was not enough space between the CTA bar and the AST.
- As foreseen in the customer procedure: the MLI should be fixed between the first ring and the second ring of lens fixture;
  As it was during the test: The MLI of the AST has been fixed on the Aluminium collar.
- As foreseen in the customer procedure: the MLI should be fixed on the third ring of the lens fixture;
  As it was during the test: The MLI between AST and baffle has been fixed between the second ring and the third ring of the lens fixture.

REMARK# 5

The power data of the TTCS I/F heaters (heaters of the CTA bar) and the temperature data of the thermal sensors labelled “3 W” have not been stored because the thermostat Watlow SD31 (used to control the TTCS I/F heaters by the thermal sensors “3W”) was not able to store or to transmit data to the pc.

REMARK# 6

The required cold temperature on the baffle (-65°C) has not been reached due to the thermo-vacuum chamber limits (minimum temperature that could be reached by the shroud is -70°C).
The minimum temperature reached on the baffle was -57,5°C (during the worst case cold) whit the shroud temperature set to -70°C and the cold plates temperature set to -45°C.

REMARK# 7

Due to some problems with the TVC temperature sensor fixed on the baffle, the PT100 of the NI acquisition system has been used during the test to control the temperature of the baffle.

TEST DIARY

DUT incoming:	June 26, 2006;
Test Set-Up:	June 26 – July 7, 2006;
Thermal Balance test:	July 7, 2006 - July 10, 2006;

TEST SETUP

During this phase the main activities performed have been:

- unpackage and bake out of the AST
- thermal sensors positioning in the TVC
- strain gages sensor verification on the AST
- thermal sensors positioning on the AST
- positioning of the AST camera in the TVC
- positioning of the AST baffle in the TVC
- heaters positioning on the AST fixture and on copper arm
- sensor wires soldering
- MLI (Multi Layer Insulant) positioning
- laser positioning and calibration
- acquisition system check
- heater temperature controllers auto-tuning and verification

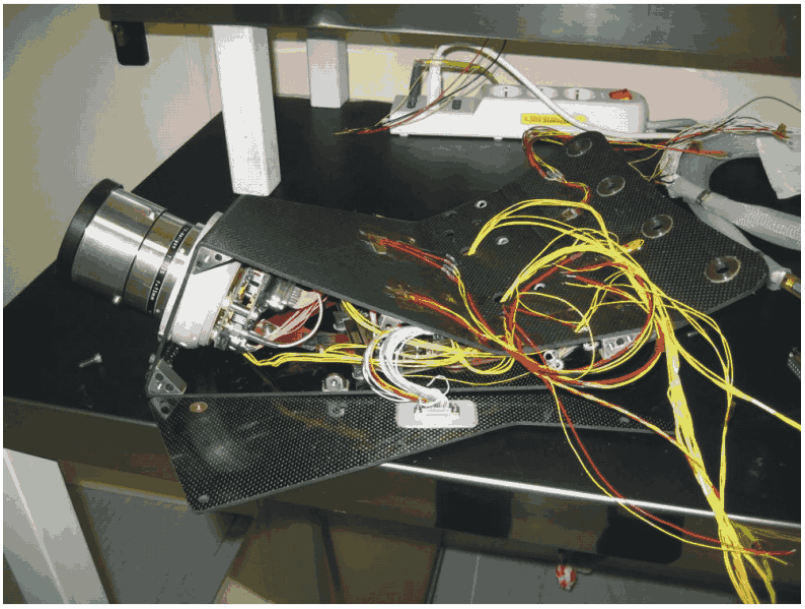
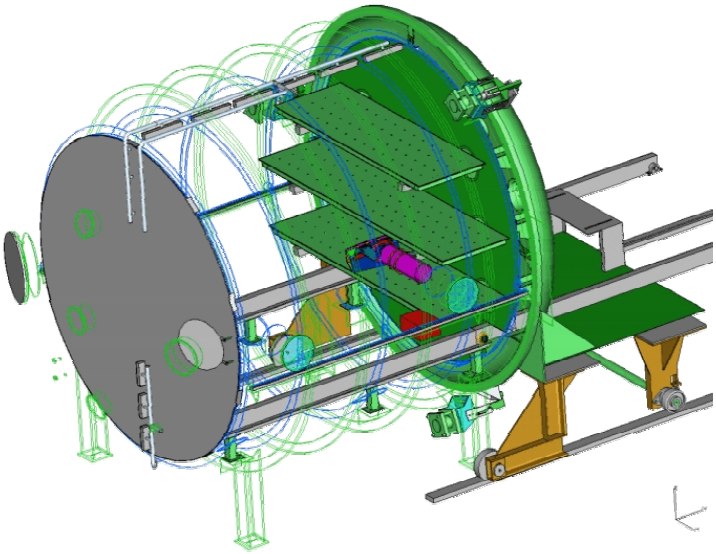
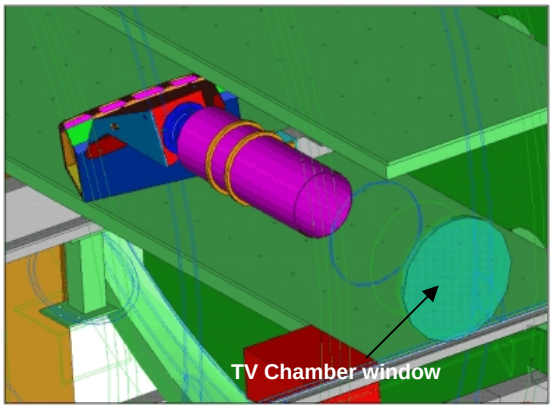
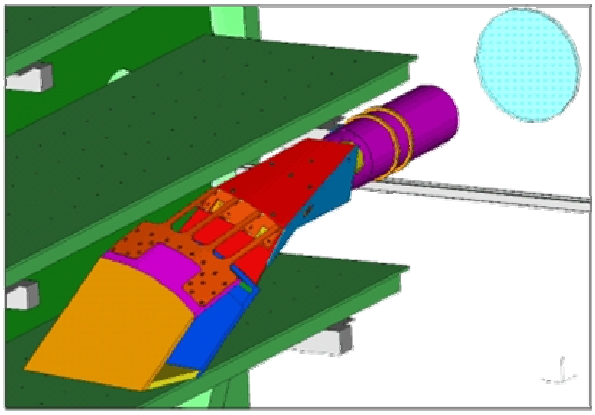


FIGURE 2 - HARDWARE UNPACKAGE PHASE AND STORAGE LOCATION POSITIONING.







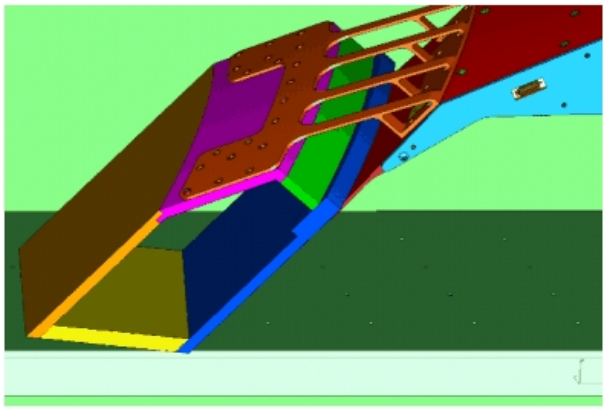


FIGURE 3 - AST POSITIONING INSIDE THE THERMO-VACUUM CHAMBER.

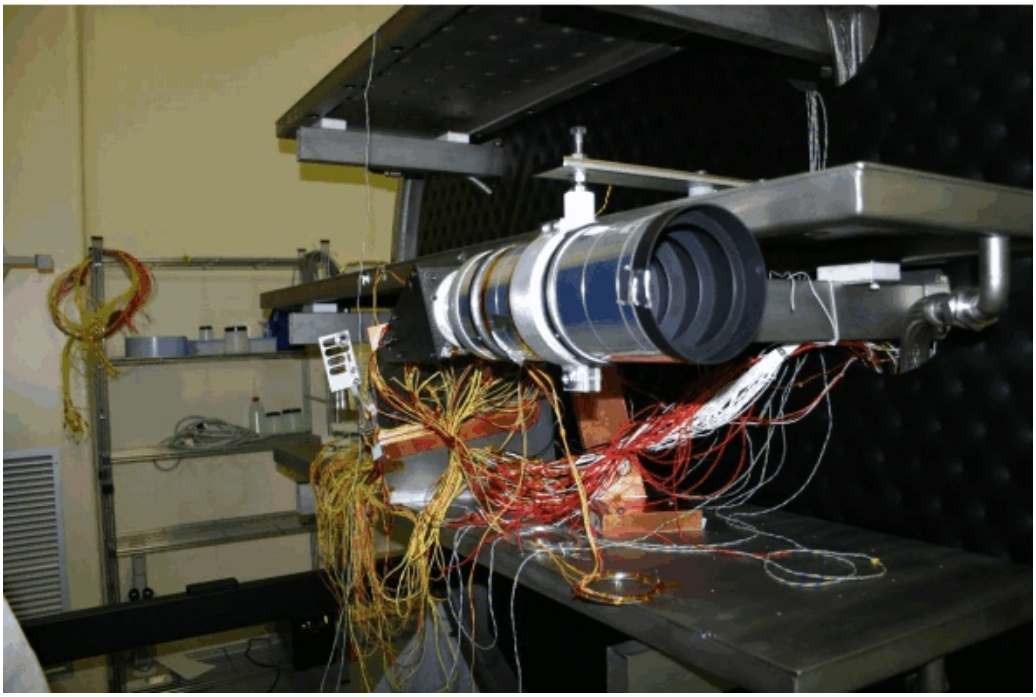


FIGURE 4 - TEST SET UP (WITHOUT MLI).

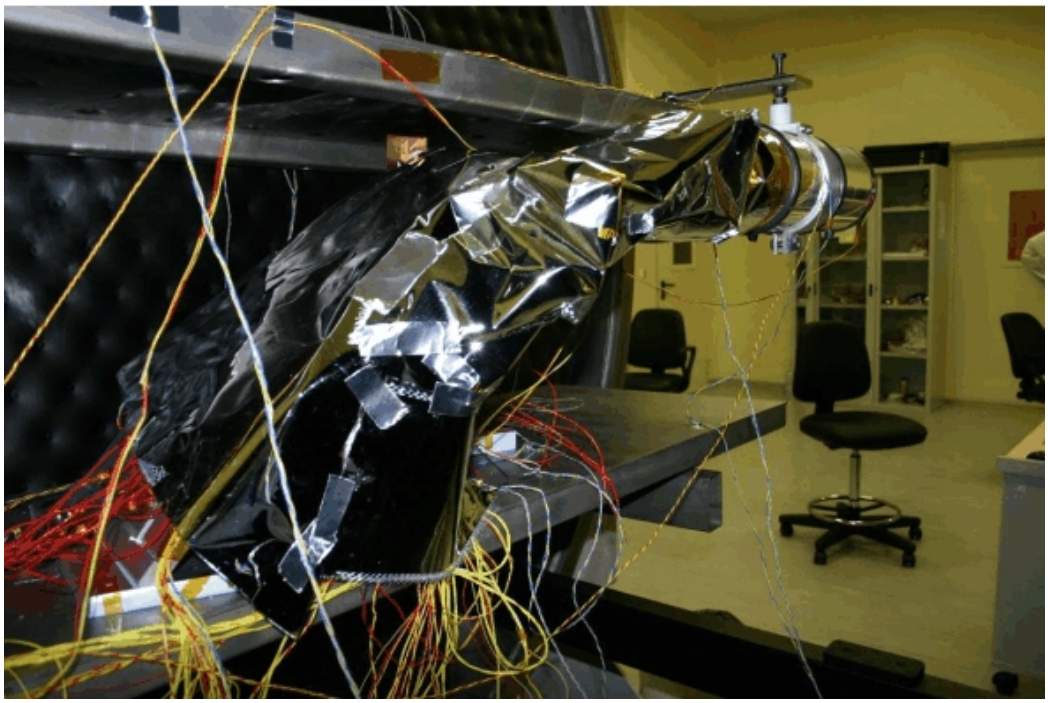


FIGURE 5 - TEST SET UP (WITH MLI).

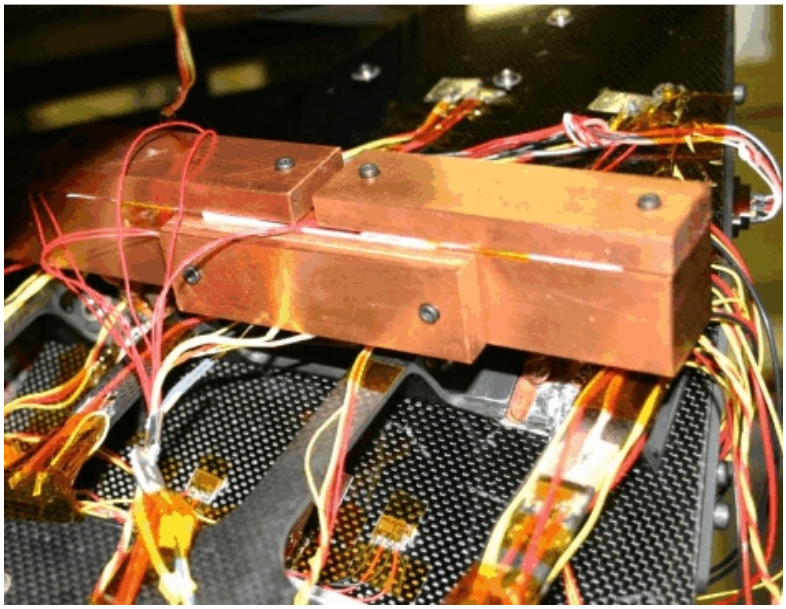


FIGURE 6 - DETAIL OF THE COPPER ARM.

THERMAL SENSORS

THERMAL SENSORS POSITIONING IN THE TVC

A total of 7 Thermal Sensors (TS) were monitoring the environmental conditions of the test (shroud and cold plates):

- 1 TS (naming scheme sensor 4) was placed on the shroud
- 6 TS were placed in different locations of the Cold Plates (CP).

In the following the TVC sensors location schemes and photographic record of positioning are presented.

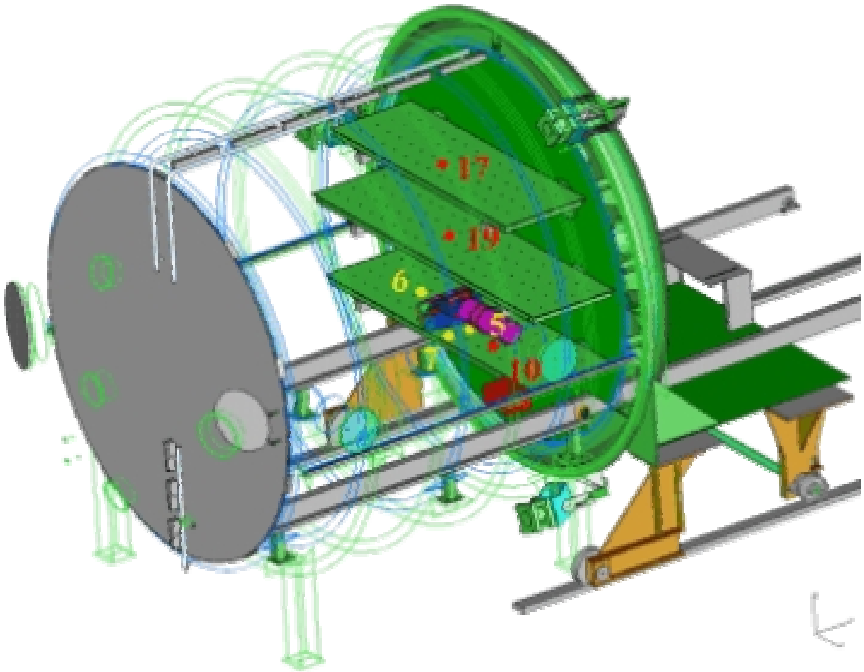


FIGURE 7 - CHAMBER SENSORS POSITIONING (COLD PLATE).

In figure 7 there is the locations of TVC sensors on CP:

- sensors 10, 17 and 19 (red in figure 7) were only for monitoring the temperature of the CP;
- sensors 5, 6, 7 (yellow in figure 7) were to control the temperature of CP.

FIGURE 8 - COLD PLATE SENSOR 17: CP UPPER.

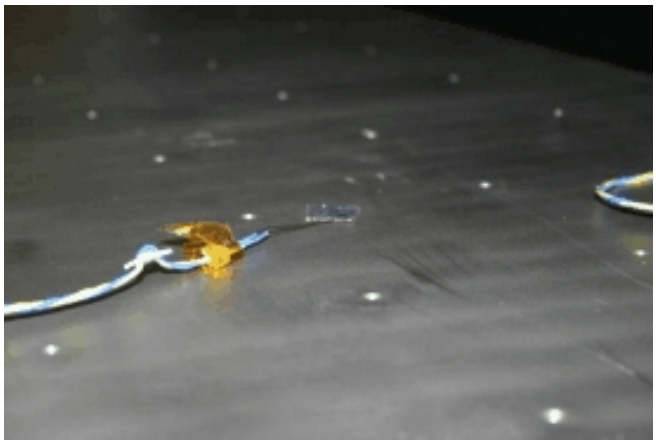


FIGURE 9 – COLD PLATE SENSOR 19: CP MIDDLE.

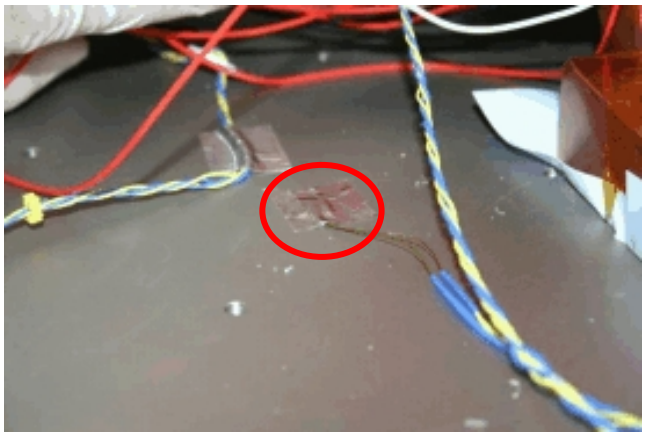


FIGURE 9 - COLD PLATE SENSOR 10: CP LOWER.

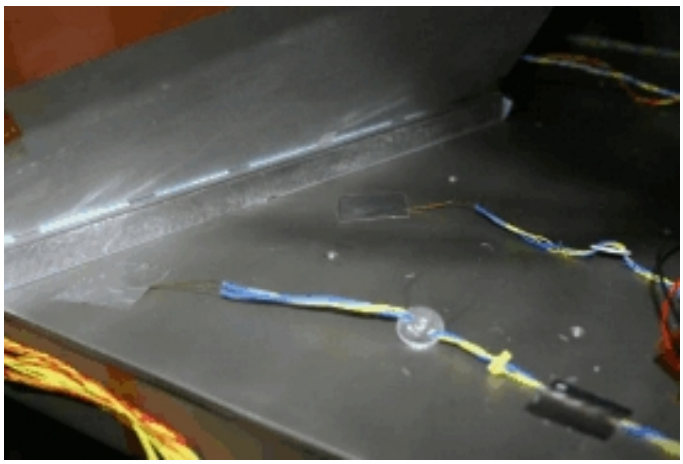


FIGURE 10 - COLD PLATE SENSOR 7 (LEFT) AND 5 (RIGHT): CP LOWER.

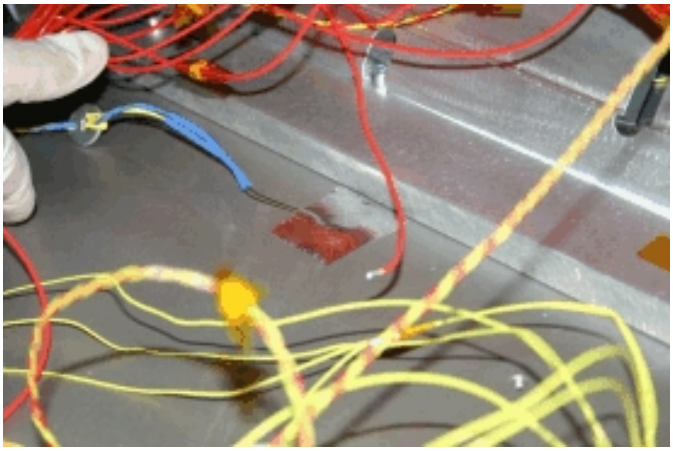


FIGURE 11 - COLD PLATE SENSOR 6: CP LOWER.

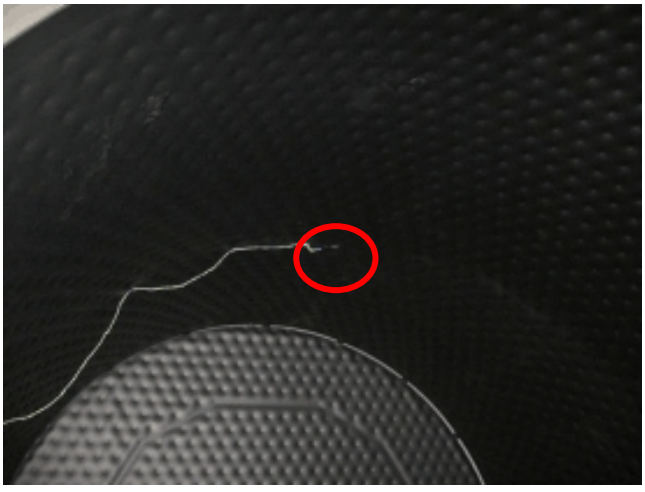


FIGURE 12 - CHAMBER SENSOR 4.

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THERMAL SENSORS POSITIONING ON THE AST

A total of 39 Thermal Sensors have been installed on the AST by INFN ROMA, CARSO and S.E.R.M.S. personnel under the direction of INFN ROMA personnel.

SYSTEM OF ACQUISITION: SCXI NATIONAL INSTRUMENTS

- 28 TS to monitor environmental parameters
  - 6 TS have been located internally to the AST, to monitor AST electronics and AST Thermal control system (ASTT)
  - 22 TS have been located externally to the AST. These are the temperature measuring points for thermal mathematical model validation and strain gage temperature compensation.
- 1 TS to control the baffle temperature (using the shroud, RADIATIVE coupling). This is one of the Temperature Reference Points of the test;
- 3 TS to control 2 different conductive interfaces (these are Temperature Reference Points, that is used as reference to control the Watlow thermostats system):
  - 1 TS on TTCS interface simulator (copper arm)
  - 2 TS on Tracker interface simulator (fixture) (2 channels: ASTS Upper and ASTS Lower)

In this document these sensors are indicated with **NI** suffix (NI system, for example 12 NI).

SYSTEM OF ACQUISITION: TVC SENSORS

- 1 TS to monitor the baffle temperature
- 3 TS to monitor 2 different conductive interfaces:
  - 1 TS on TTCS interface simulator (copper arm)
  - 2 TS on Tracker interface simulator (fixture) (2 channels: ASTS Upper and ASTS Lower)

In this document these sensors are indicated with **TVC** suffix (TVC system, for example 12 TVC).

HEATERS CONTROL SYSTEM: WATLOW THERMOSTATS SENSORS

Watlow thermostats system was made up by 2 thermostats and 6 heaters to operate 2 different conductive interfaces:
- 1 thermostat Watlow SD31 to control the TTCS interface simulator (copper arm) by 1 TS (**TEMPERATURE DATA NOT ACQUIRED**: the SD31 thermostat sensor was not able to acquire data on a PC) and 4 heaters (connected in parallel mode to DC power (0-30 V, 68 W all heaters full maximum power)). 3 of these 4 heaters are showed in figure 6, mounted on the copper arm.
- 1 thermostat Watlow PD (2 channels) to control the Tracker interface simulator (fixture) by 2 TS and 2 heaters:
  - 1 TS and 1 heater (connected to AC power (220 V, 180 W maximum power)) on ASTS Upper Tracker Interface fixture
  - 1 TS and 1 heater (connected to AC power (220 V, 180 W maximum power)) on ASTS Lower Tracker Interface fixture

In this document these sensors are indicated with **W** suffix (Watlow system, for example 12 W).

After positioning, all sensors have been tested to verify possible failures after installation. During the test, before the Worst Hot Stabilization phase, two of them resulted not bonded to their monitored surface: 16 TVC and 29 NI. This last sensor was initially used like Temperature Reference Point (TRP), but after the debonding, the sensor 16 NI was used like TRP.
After baffle disassembly, Silver Teflon slippery surface was traced as reason for this problem. In fact 16 NI sensor was not bonded to this surface, but to black anodized aluminium baffle surface (rougher).

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INFN ROMA - CARSO

CHANNEL – THERMAL SENSOR CROSS REFERENCE TABLE

In the following table the correspondence between the temperature acquisition channels, the naming scheme used in presenting the test results and the actual sensor location is given.

SYSTEM OF ACQUISITION: SCXI NATIONAL INSTRUMENTS

Channel number	Sensor name	Location
1 NI	102A	ASTSUpper (I/F ASTS/SiT Plane1) - On composite upper side (close to SG 7) Also for SG 8 compensation
2 NI	102	ASTSUpper (I/F ASTS/SiT Plane1) - On composite upper side (close to SG 1) Also for SG 2 compensation
3 NI	101	ASTSLower (I/F ASTS/SiT Conical Flange) - On composite external side
4 NI	102B	ASTSUpper - On composite upper side (close to SG 3)
5 NI	102C	ASTSUpper - On composite upper side (close to SG 5)
6 NI	102D	ASTSUpper (I/F ASTS/SiT Plane1) - On composite upper side (close to SG 13)
7 NI	104	ASTSUpper (I/F ASTS Upper/El Board) On composite centered under the el board external side (close to SG 4)
8 NI	105	ASTSUpper (I/F ASTS Upper/Lens) - On composite front close to the collar
9 NI	104A	ASTSUpper (I/F ASTS Upper/El Board) On composite centred under the el board external side (close to SG 6)
10 NI	106	ASTSCollar (I/F ASTS/CCD and CCD1) - On Al collar where possible
11 NI	5	ASTCO lens
12 NI	6	ASTCO lens cover - Close to the filters
13 NI	M1	TTCS Copper block (braid) - I/F AST_Tbridge
14 NI	M2	TTCS Copper block (braid) - I/F TTCS (CTA)
15 NI	M3	TTCS Copper block (braid) - I/F AST_Tbridge (ASTS_side)
16 NI	**110**	**Baffle - Close to the top border**
17 NI	111	ASTSLower - Side Rib (close to SG 10) - Also for SG 9 compensation
18 NI	112	ASTSLower - Side Rib (close to SG 12) (ASTS side) Also for SG 11 compensation
19 NI	103	ASTSLower (I/F ASTS Upper/Lower) - On composite lower side
20 NI	M4	TTCS Copper block (braid) - I/F TTCS (CTA) (ASTS_side)
21 NI	F1	Baffle fixture (steel bar)
22 NI	**CH3**	**TTCS I/F**
23 NI	3	ASTCD ccd board 2 - On PCB board
24 NI	2	ASTCE electronic board 3 - On PCB board
25 NI	1	ASTCE electronic board 3 - On ACTEL FPGA
26 NI	108	ASTS Thermal bridge - On copper
27 NI	107	ASTS Thermal bridge - On copper
28 NI	4	ASTCD ccd board 1 - On copper plate

Channel number	Sensor name	Location
29 NI	109	Baffle - Close to the lens
30 NI	F2	CTA vertical bar
31 NI	**CH2**	**Tracker I/F Upper**
32 NI	**CH1**	**Tracker I/F Lower**

Bold characters mean TRP (Temperature Reference Point) Pt100 Sensors

SYSTEM OF ACQUISITION: TVC SENSORS

Channel number	Sensor name	Location
8 TVC	CH2	Tracker I/F Upper
9 TVC	CH1	Tracker I/F Lower
16 TVC	109	Baffle - Close to the lens
18 TVC	CH3	TTCS I/F

HEATERS CONTROL SYSTEM: WATLOW THERMOSTATS SENSORS

Channel number	Sensor name	Location
1 W	CH1	Tracker I/F Lower
2 W	CH2	Tracker I/F Upper
3 W	CH3	TTCS I/F **(DATA NOT ACQUIRED)**

INTERNAL THERMAL SENSORS LAYOUT

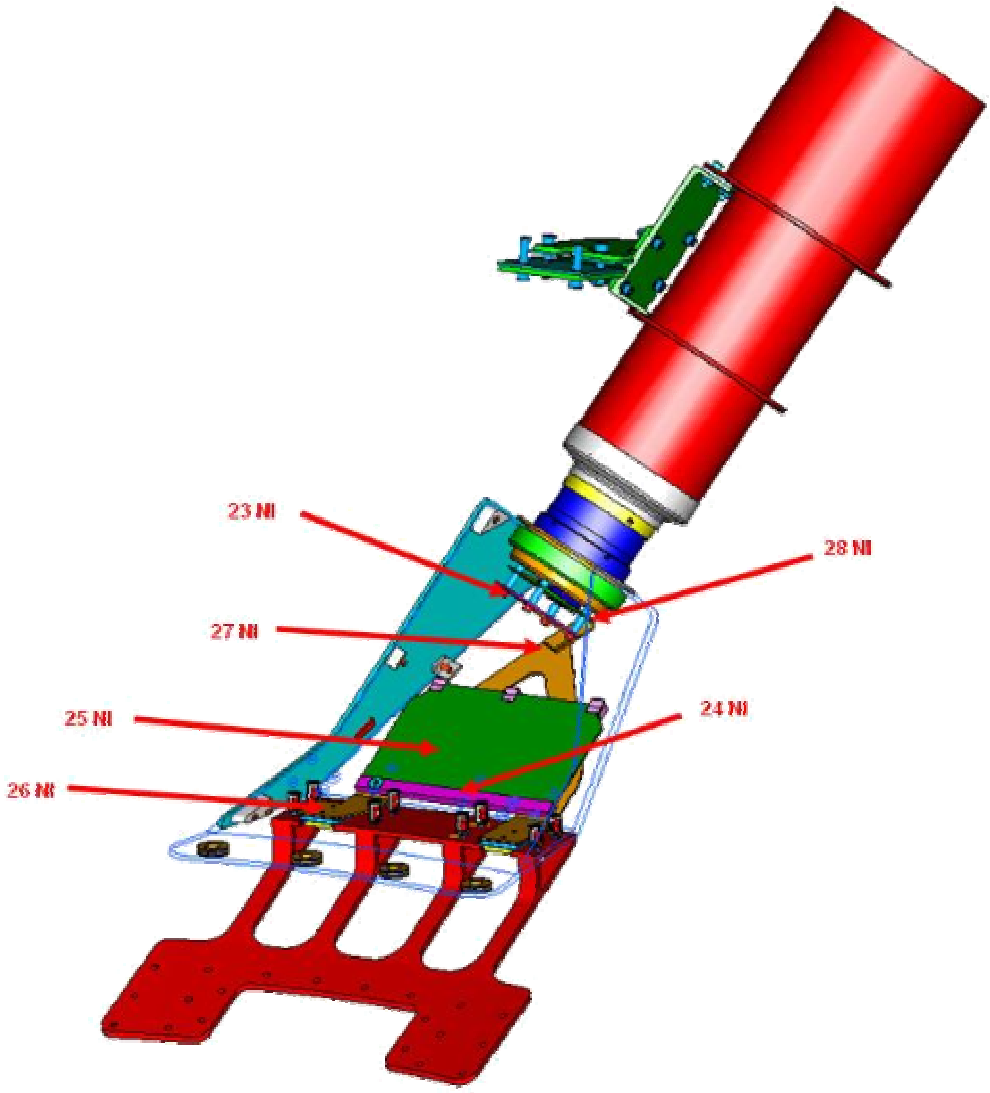

FIGURE 13 - INTERNAL SENSORS LAYOUT.

EXTERNAL THERMAL SENSORS LAYOUT

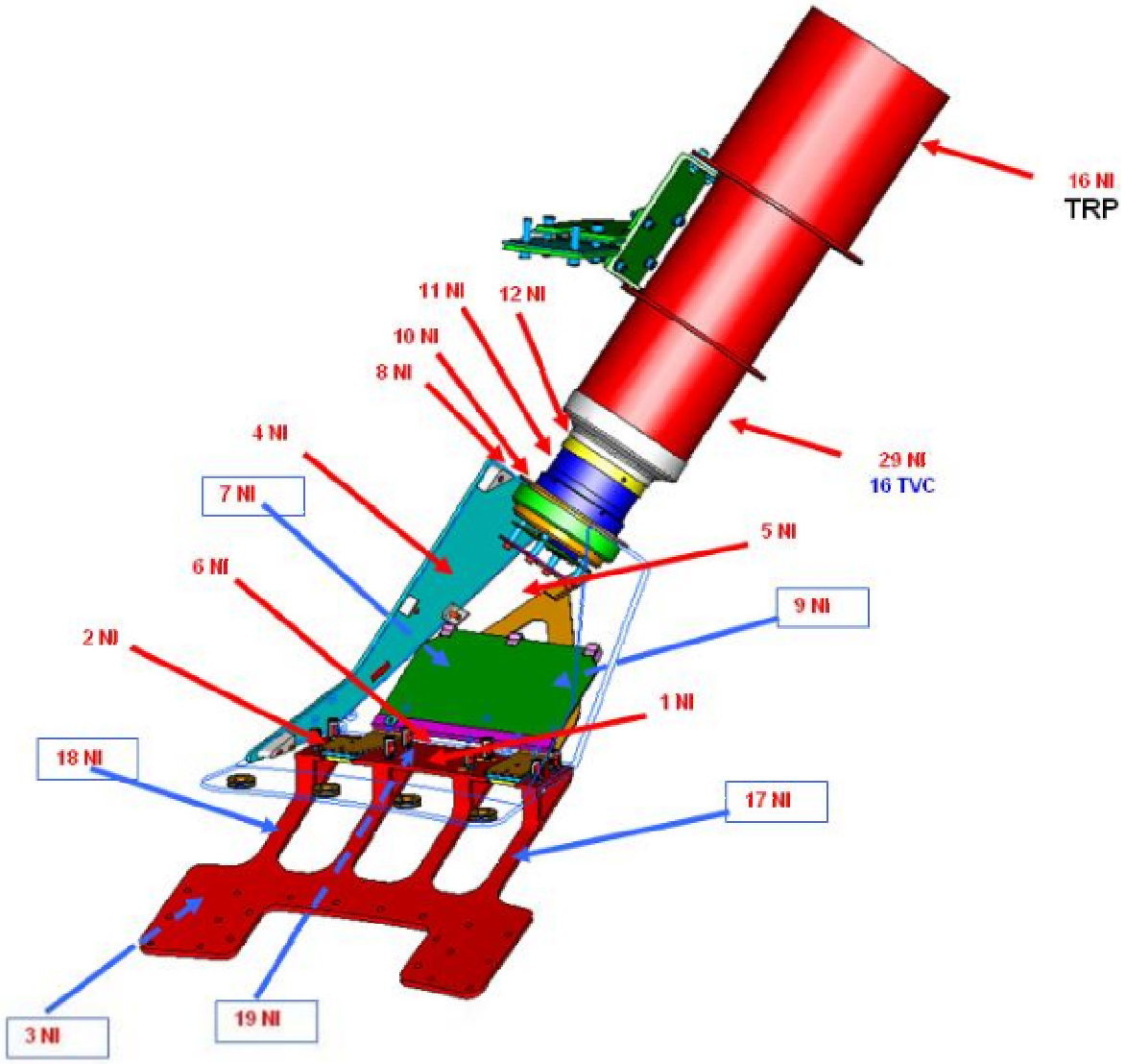

FIGURE 14 - EXTERNAL SENSORS LAYOUT – MONITOR SENSORS.

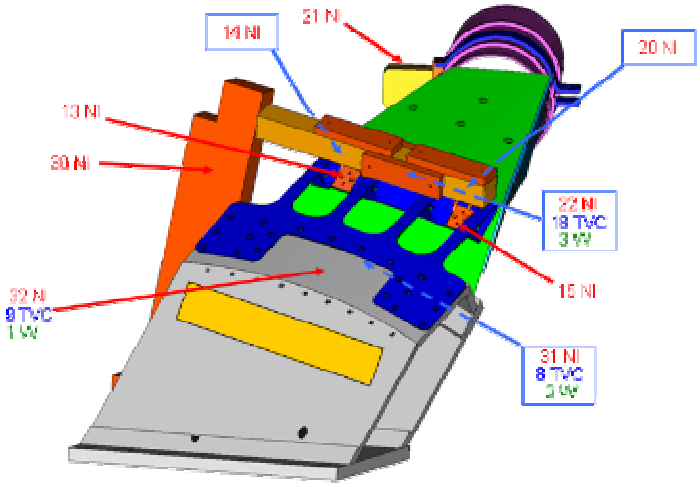

FIGURE 15 - EXTERNAL SENSORS LAYOUT - CONTROL SENSORS.

Blue arrows indicates sensors not visible from this point of view

EXTERNAL THERMAL SENSORS PICTURES

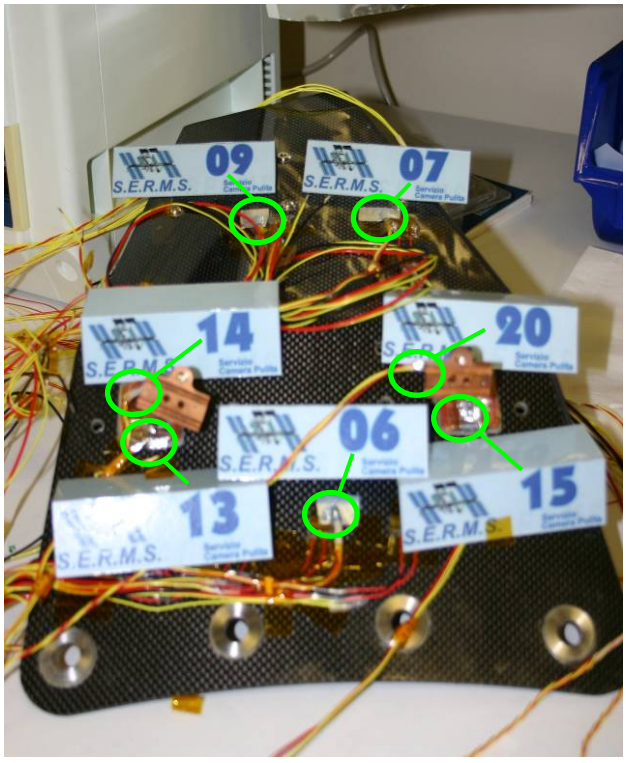

FIGURE 16 - EXTERNAL PT100 SENSORS (6 NI – 7 NI – 9 NI – 13 NI – 14 NI – 15 NI – 20 NI)

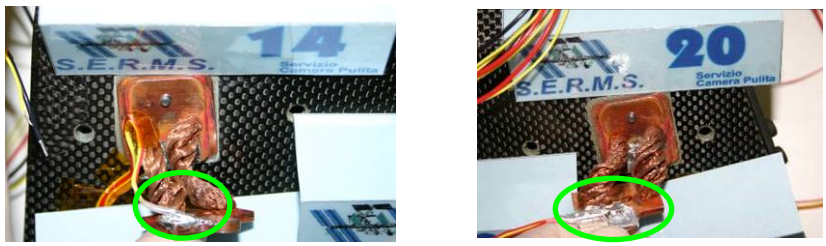

FIGURE 17 - EXTERNAL PT100 SENSORS (14 NI – 20 NI)

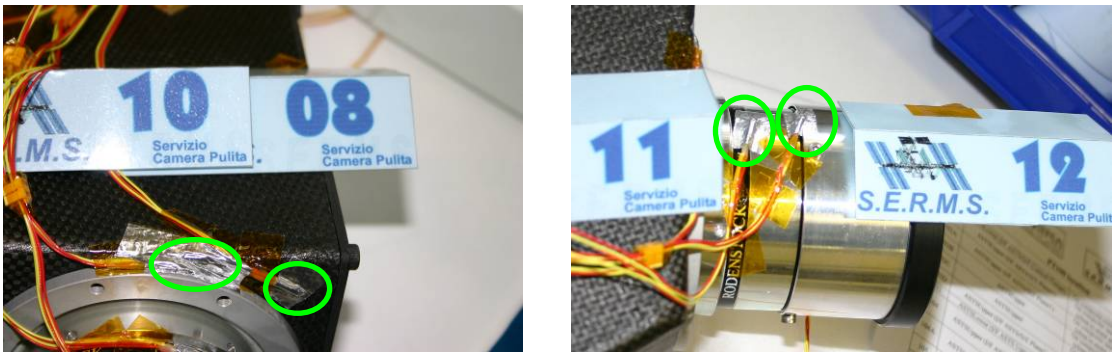

FIGURE 18 - EXTERNAL PT100 SENSORS (8 NI – 10 NI – 11 NI – 12 NI)

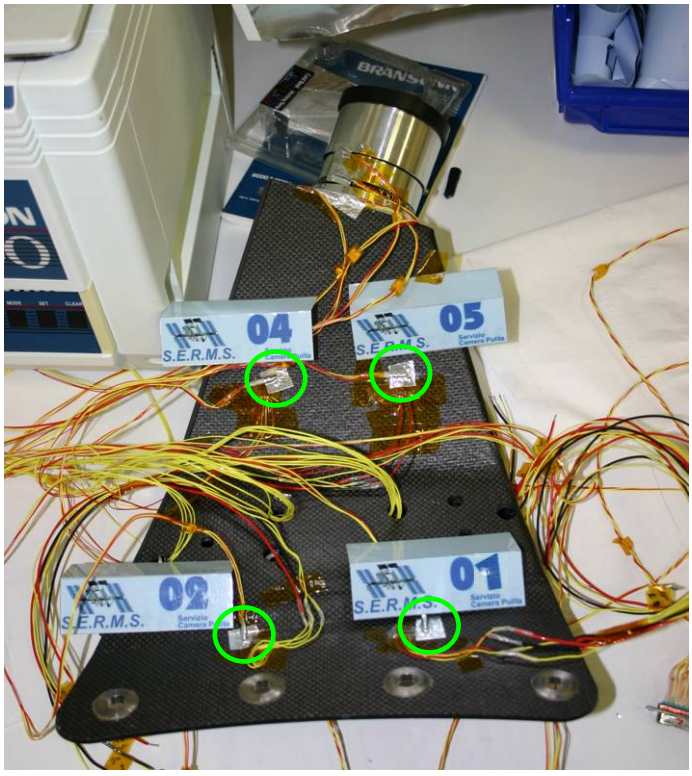

FIGURE 19 - EXTERNAL PT100 SENSORS (1 NI – 2 NI – 4 NI – 5 NI)

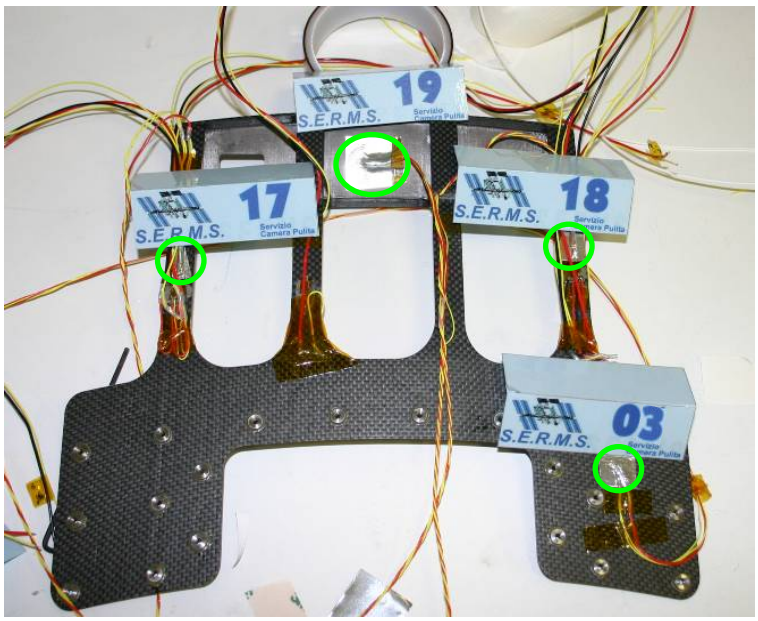

FIGURE 20 - EXTERNAL PT100 SENSORS (3 NI – 17 NI – 18 NI – 19 NI)

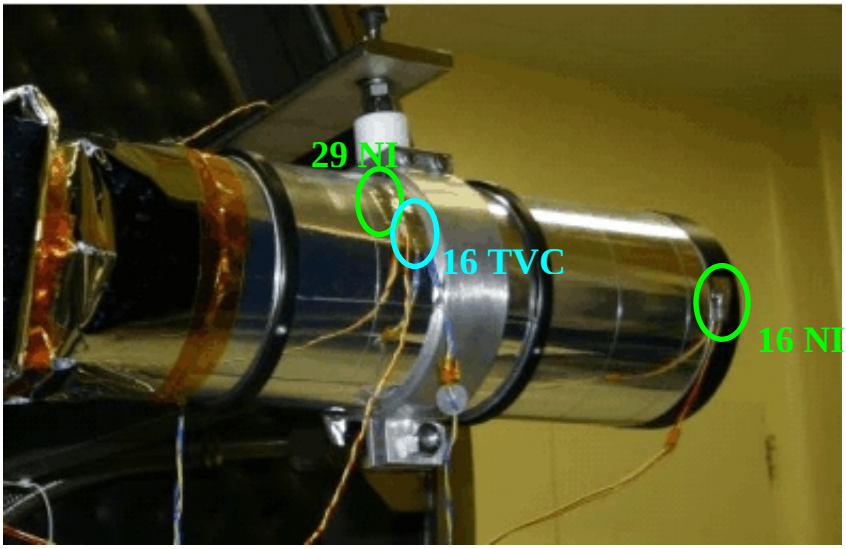

FIGURE 21 - EXTERNAL PT100 SENSORS (16 NI – 29 NI – 16 TVC)

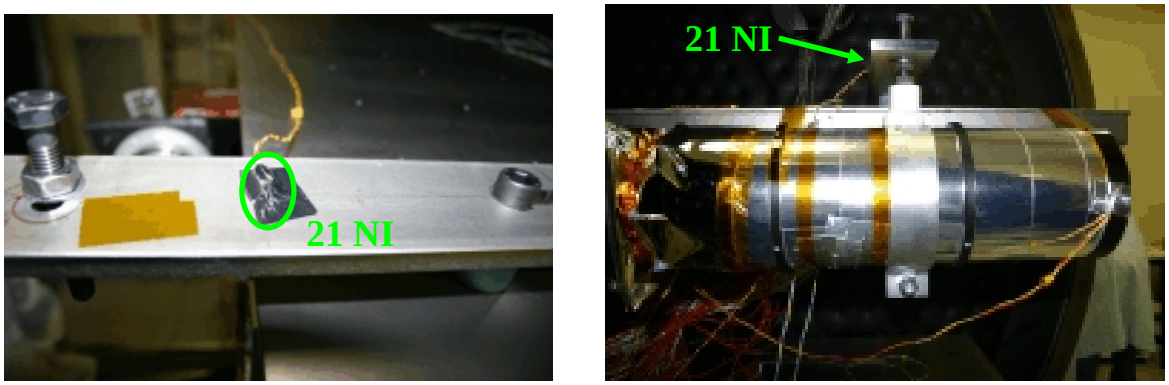

FIGURE 22 - EXTERNAL PT100 SENSOR (21 NI)

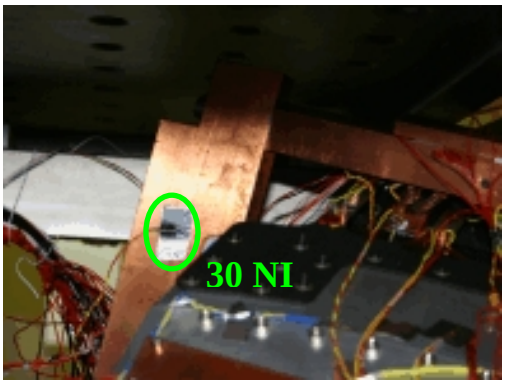

FIGURE 23 - EXTERNAL PT100 SENSOR (30 NI)

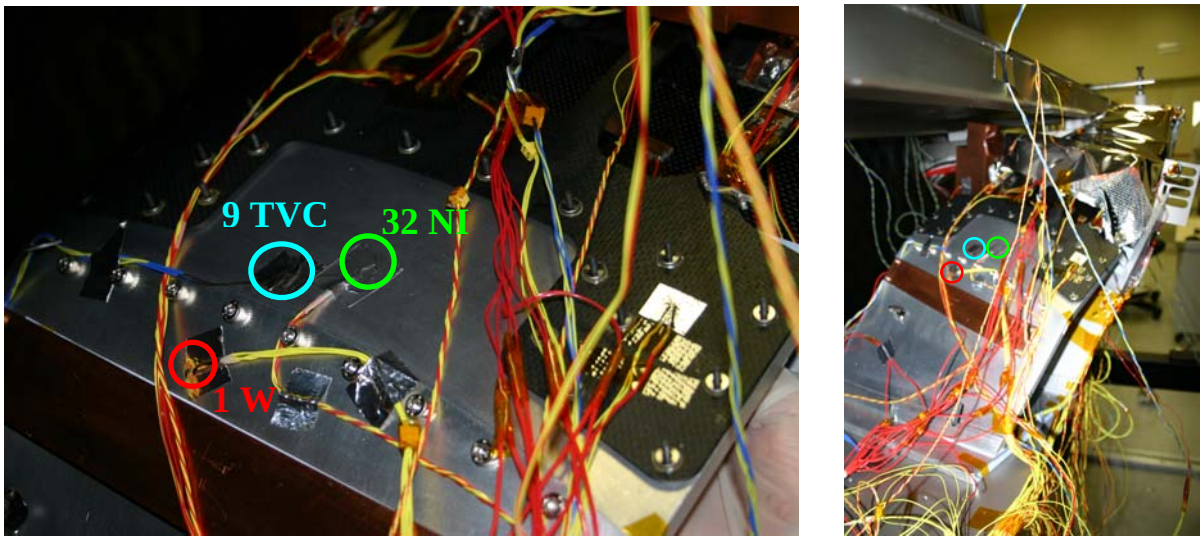

FIGURE 24 – THERMAL BALANCE FIXTURE (TRACKER I/F LOWER) THERMAL SENSORS (32 NI – 1 W – 9 TVC)

FIGURE 25 – THERMAL BALANCE FIXTURE (TRACKER I/F UPPER) THERMAL SENSORS (31 NI – 2 W – 8 TVC)

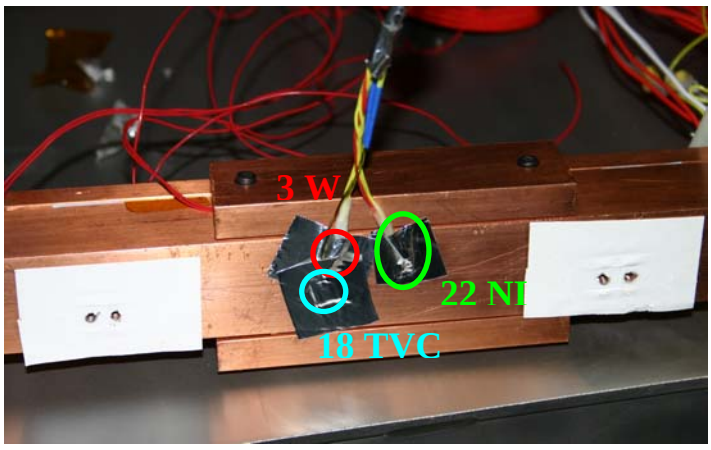

FIGURE 26 – COPPER THERMAL ARM THERMAL SENSORS (22 NI – 3 W – 18 TVC)

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INFN ROMA - CARSO

DEFORMATION MONITORING SYSTEM

STRAIN GAGE POSITIONING ON THE AST

A total of 14 strain gages have been installed on the AST by INFN ROMA, CARSO and S.E.R.M.S. personnel under the direction of INFN ROMA personnel.

- 13 strain gages have been installed to monitor local deformation of the ASTS composite structure: each strain gage is a rosetta (biaxial, 0°/90°, with an acquisition channel for each grid): **26 acquisition channels**.
  All strain gage grids have been arranged in a quarter bridge configuration.
  Thermal compensation of those channels has been performed offline by temperature sensors (Pt100 placed near strain gages) values.
- 1 strain gage channel has been installed to monitor the bending of an ASTS Lower rib: this channel is constituted by 2 strain gages (uniaxial): **1 acquisition channel**.
  These two strain gages have been arranged in a half bridge configuration (two strain gages acquired by a channel), mounted on the opposite faces of the rib. This channel was auto thermal compensated.

In this document these sensors are indicated with **SG** suffix (SG system, for example 12 SG).

After positioning, all sensors have been tested to verify possible failures after installation. However during the Worst Hot Stabilization phase, during and before the Worst Cold Stabilization phase the acquisition system didn't stored the strain data, because acquisition software crashed. Strain gages number: 1 SG (0° and 90° channels), 5 SG (90° channel), 7 SG (90° channel) didn't work properly for gluing problems. Strain gage channel number 14 SG didn't work for electrical connection failures.

CHANNEL – STRAIN GAGE CROSS REFERENCE TABLE

In the following table the correspondence between the deformation acquisition channels, the naming scheme used in presenting the test results and the actual sensor location is given.

Channel number	Position	Name
1 SG	ASTSU	External Upper surface
2 SG	ASTSU	External Lower surface (opposite to 1 SG)
3 SG	ASTSU	External Upper surface
4 SG	ASTSU	External Lower surface (opposite to 3 SG)
5 SG	ASTSU	External Upper surface
6 SG	ASTSU	External Lower surface (opposite to 5 SG)
7 SG	ASTSU	External Upper surface
8 SG	ASTSU	External Lower surface (opposite to 7 SG)
9 SG	ASTSL	Side rib
10 SG	ASTSL	Side rib (opposite to 9 SG)
11 SG	ASTSL	Side rib

Channel number	Position	Name
12	ASTSL	Side rib (opposite to 11 SG)
13	ASTSU	External lower surface (between 2 SG and 8 SG)
14	ASTSL	Central rib (close to rib containing 9 SG and 10 SG)

STRAIN GAGE LAYOUT

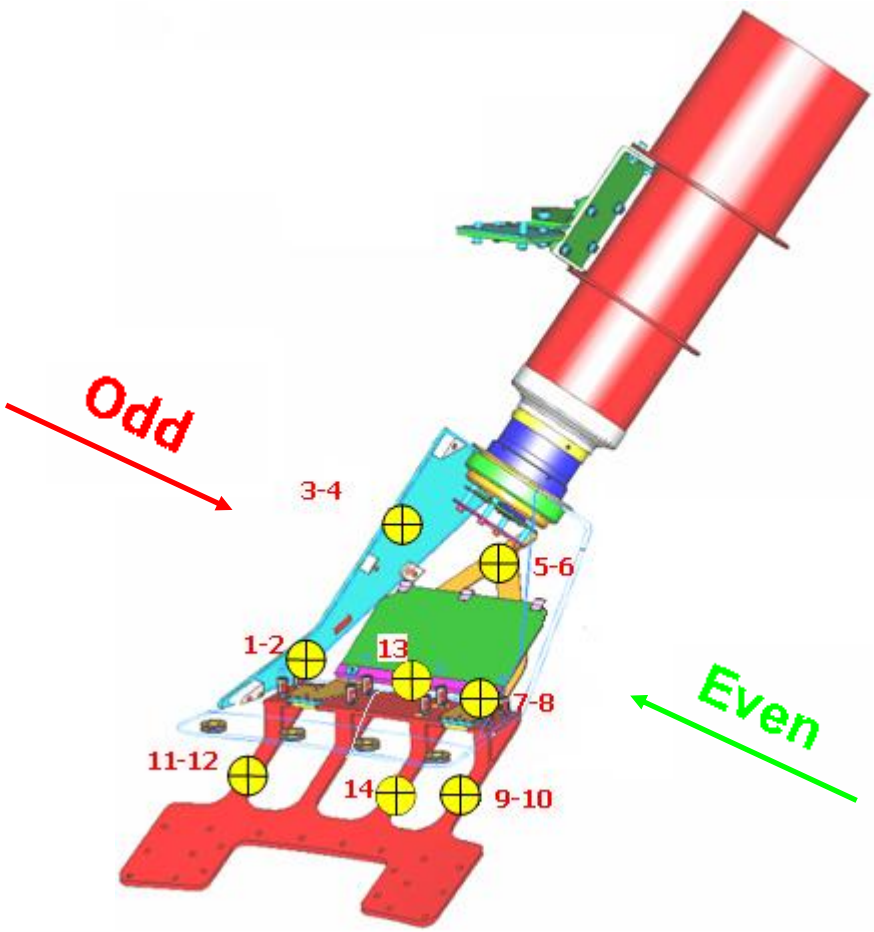

FIGURE 27 - STRAIN GAGE SENSORS LAYOUT.

Even strain gages, from label number 2 SG to 12 SG, have been installed on the AST face highlighted by the **green** arrow. Also strain gage labelled as number 13 SG was installed on the AST face highlighted by the **green** arrow.
Odd strain gages, from label channel number 1 SG to 11 SG, have been installed on the AST face highlighted by the **red** arrow.
Channel number 14 SG strain gage was composed of two uniaxial (single channel) strain gage mounted on the opposite faces of the central ASTS Lower rib.

STRAIN GAGE PICTURES

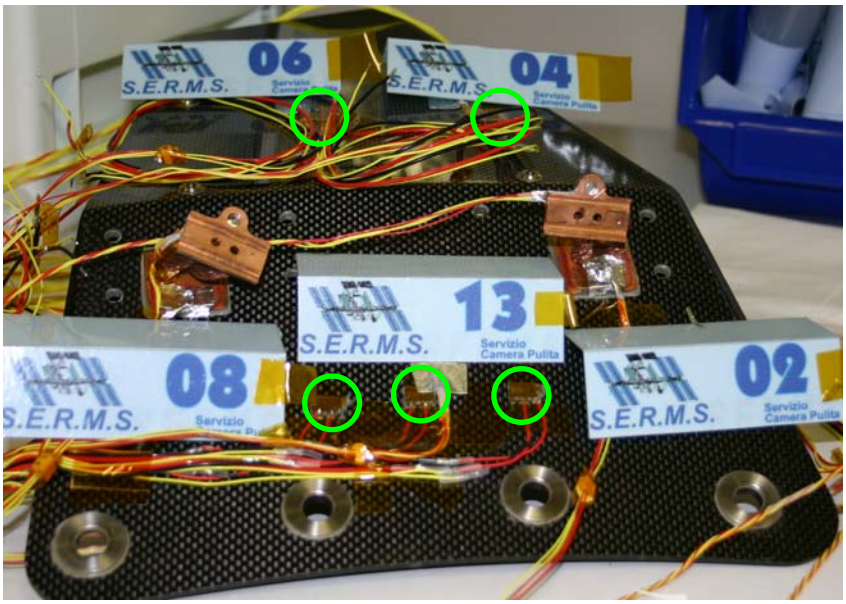

FIGURE 28 - STRAIN GAGE SENSORS (2 SG – 4 SG – 6 SG – 8 SG – 13 SG)

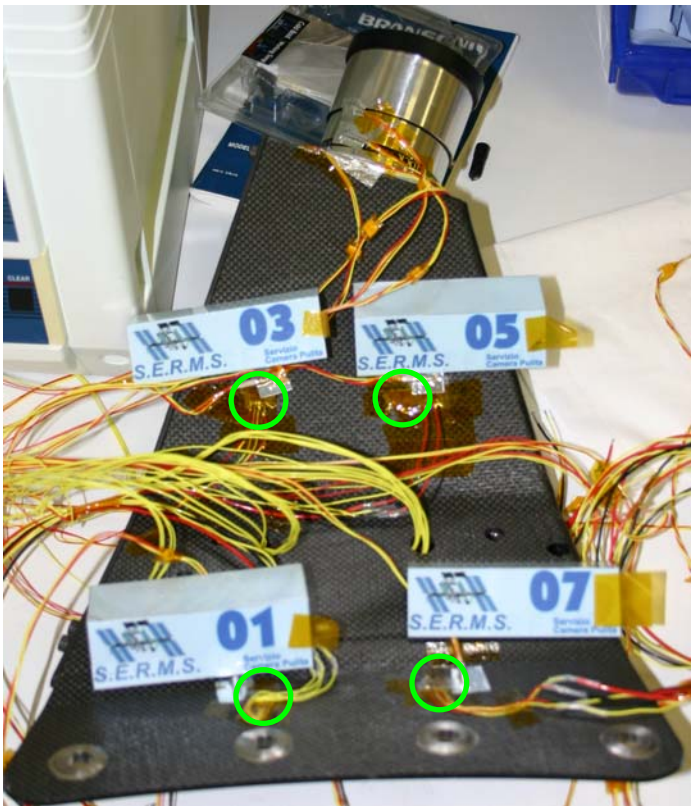

FIGURE 29 - STRAIN GAGE SENSORS (1 SG – 3 SG – 5 SG – 7 SG)

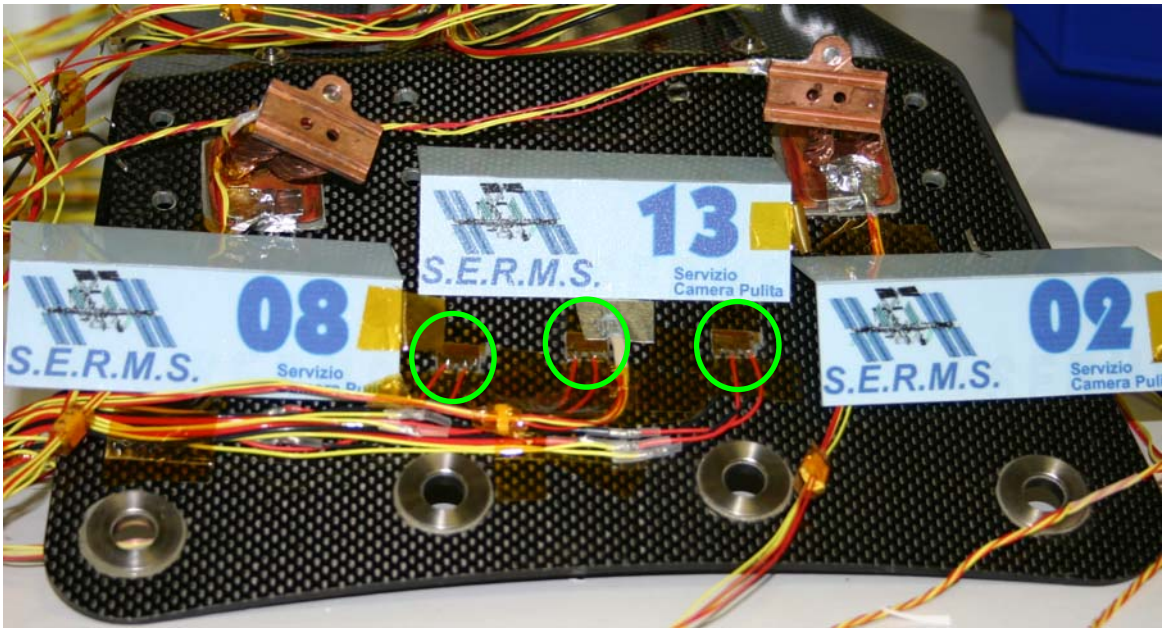

FIGURE 30 - STRAIN GAGE SENSORS (2 SG – 8 SG – 13 SG)

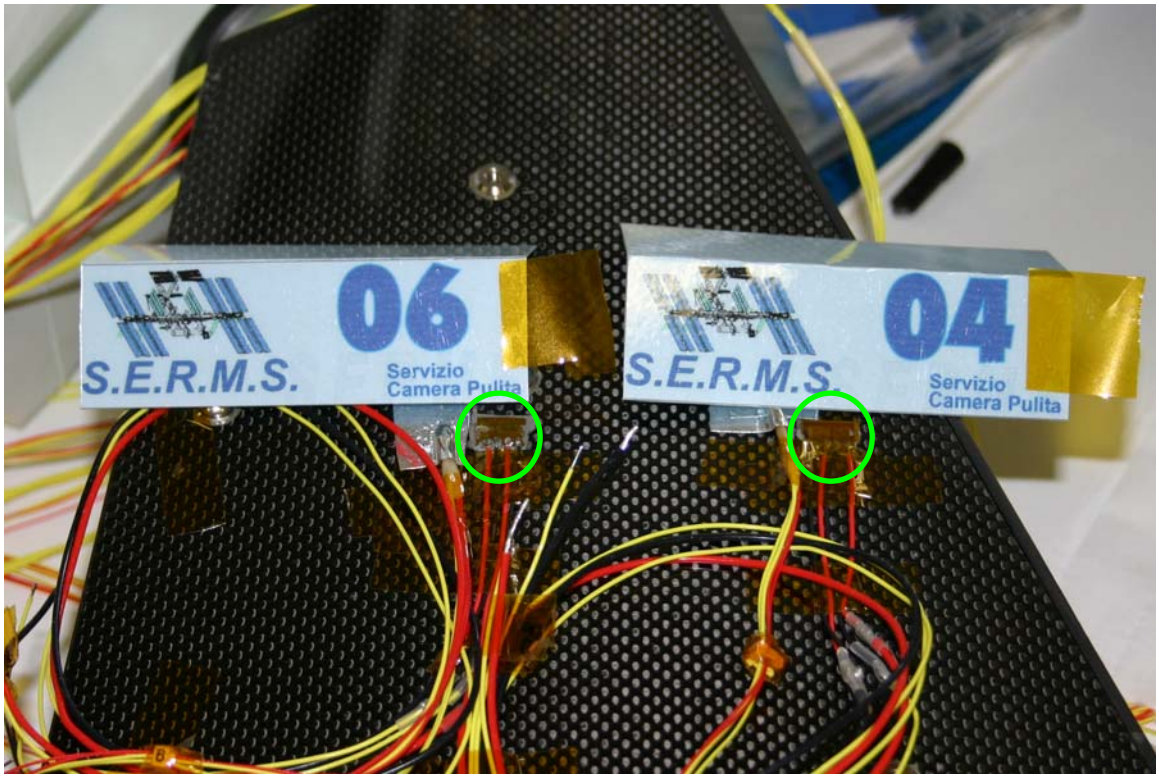

FIGURE 31 - STRAIN GAGE SENSORS (4 SG – 6 SG)

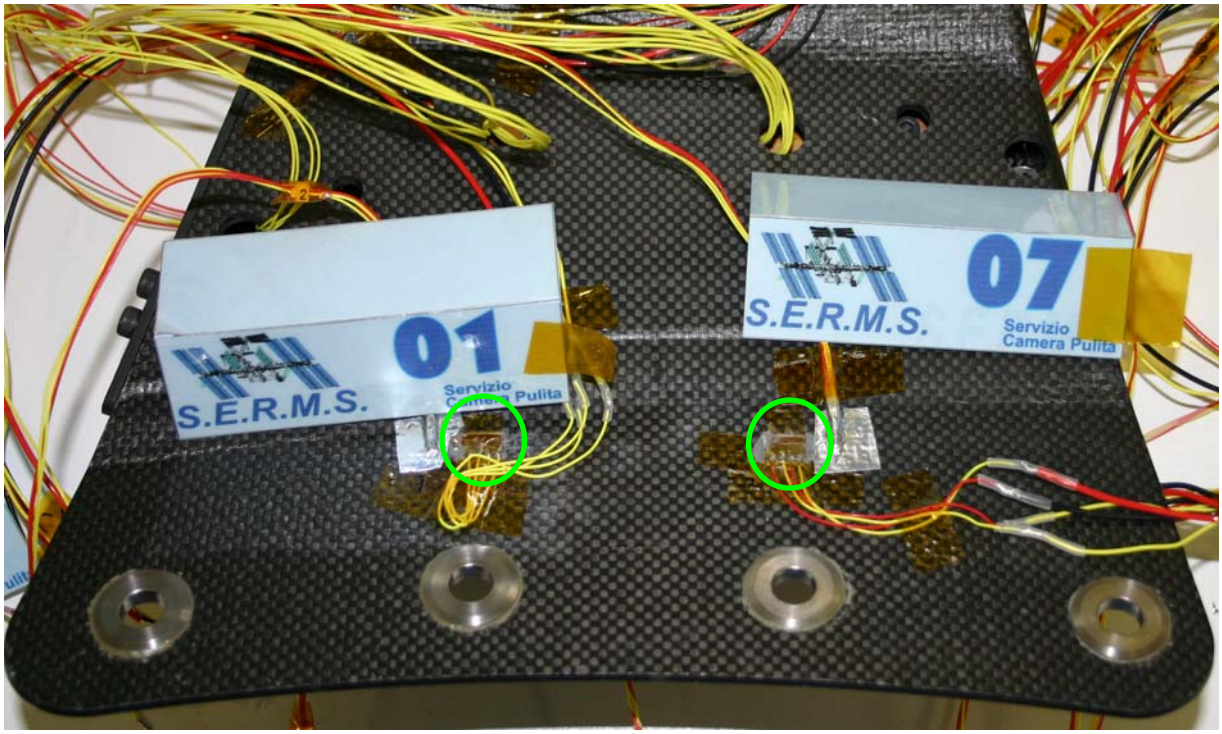

FIGURE 32 - STRAIN GAGE SENSORS (1 SG – 7 SG)

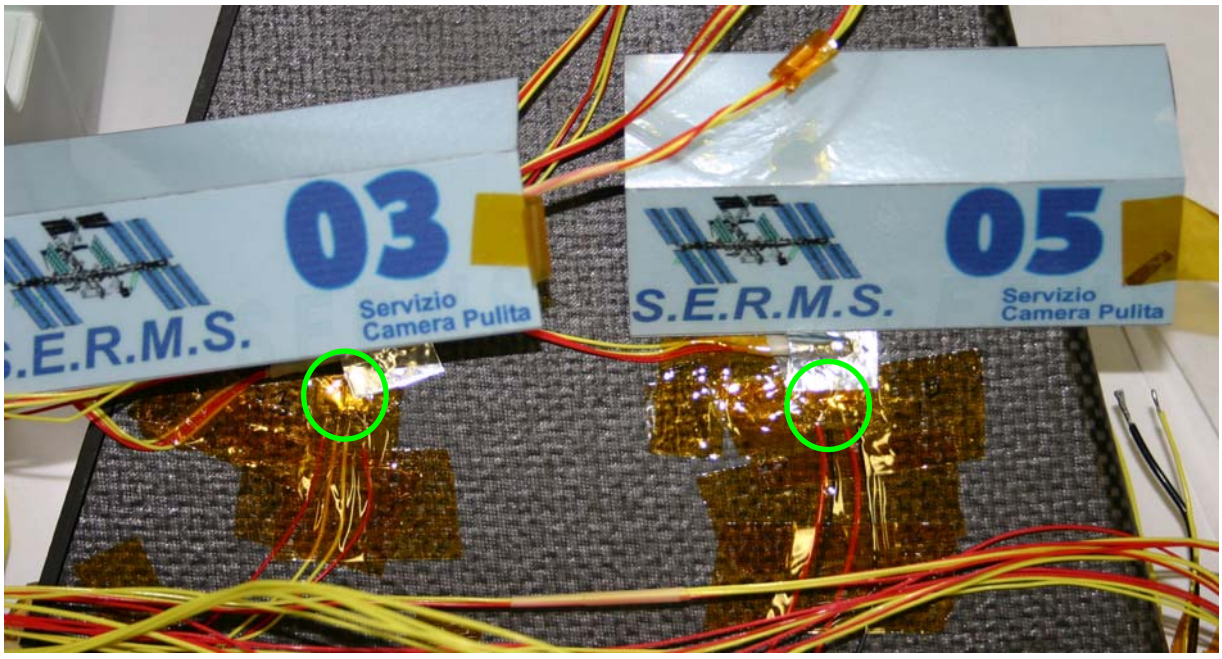

FIGURE 33 - STRAIN GAGE SENSORS (3 SG – 5 SG)

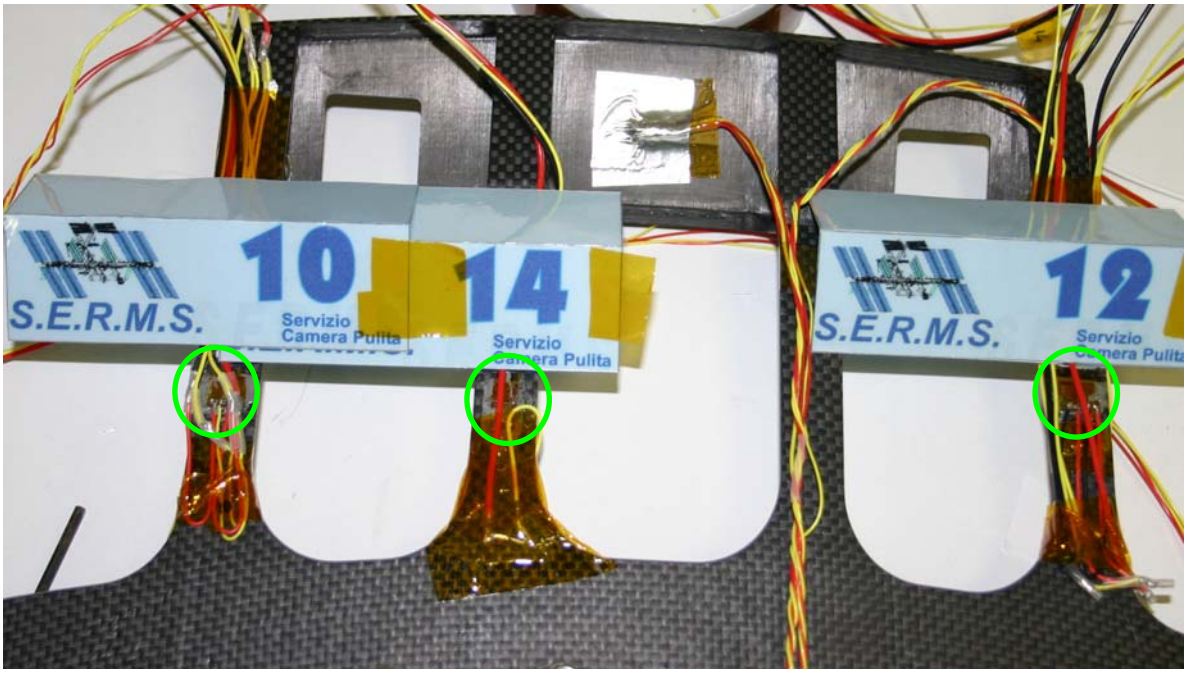

FIGURE 34- STRAIN GAGE SENSORS (10 SG – 14 SG – 12 SG)

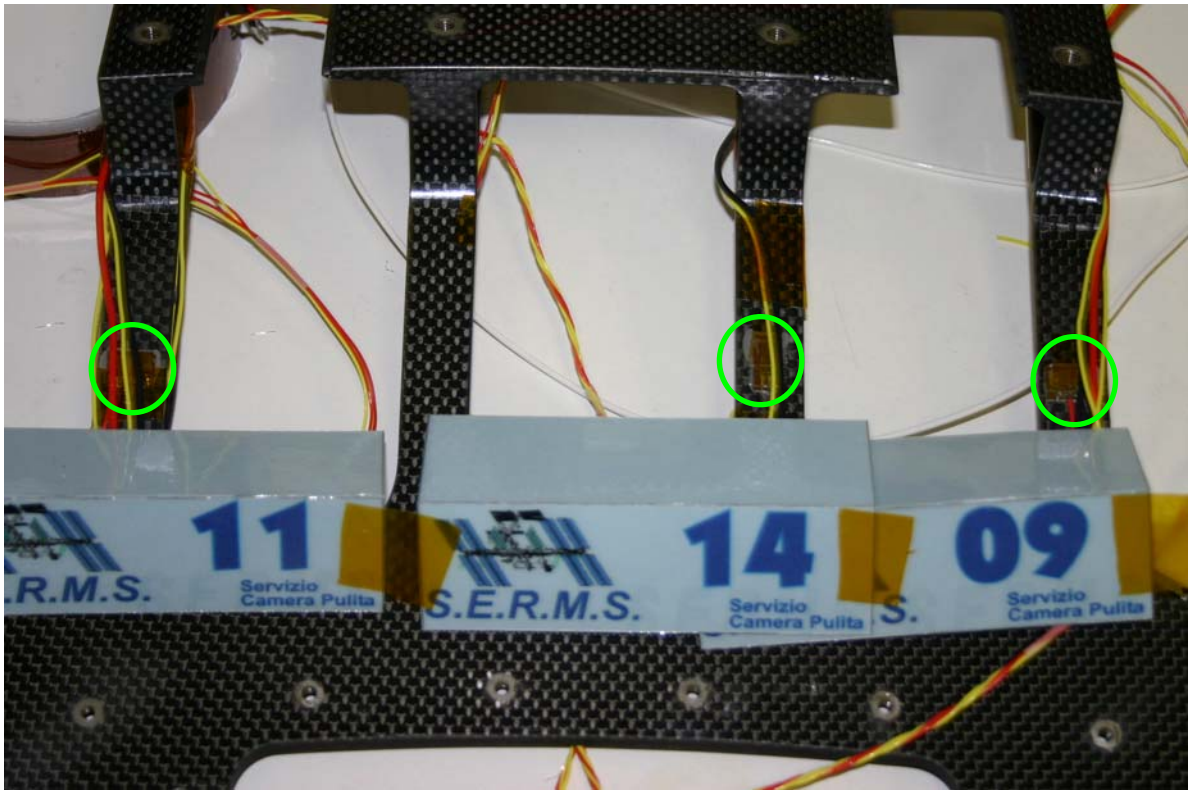

FIGURE 35- STRAIN GAGE SENSORS (11 SG – 14 SG – 9 SG)

LASERS POSITIONING ON THE AST

The AME (Alignment Monitoring Equipment, that was made up of 2 lasers and 1 external CCD) has been installed on the AST by INFN ROMA, CARSO and S.E.R.M.S. personnel under the direction of INFN ROMA personnel.

- The external laser has been installed to point the AST camera. This system was conceived to monitor the global lens axis deviation, due to the thermal deformation of the system made up of: cold plate, aluminium fixture, ASTS composite, AST camera.
- The internal laser has been installed to point the external CCD. This system was conceived to monitor the fixture deformation, due to the thermal deformation of the system made up of cold plate and aluminium fixture.

The comparison between the deformations acquired gives the deformation of the AST composite plus AST camera.

LASERS LAYOUT

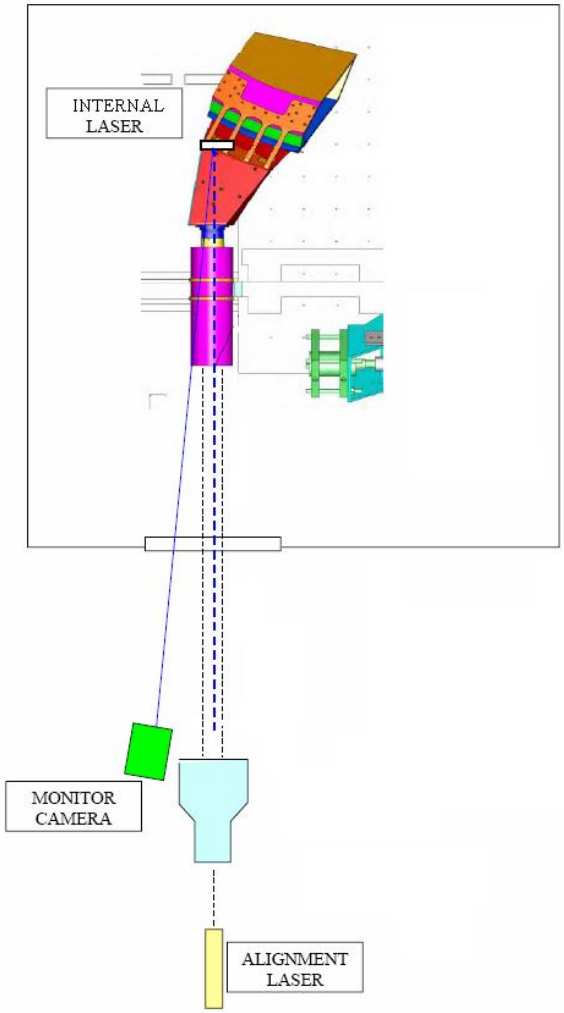

FIGURE 36 - LASERS LAYOUT.

LASER PICTURES

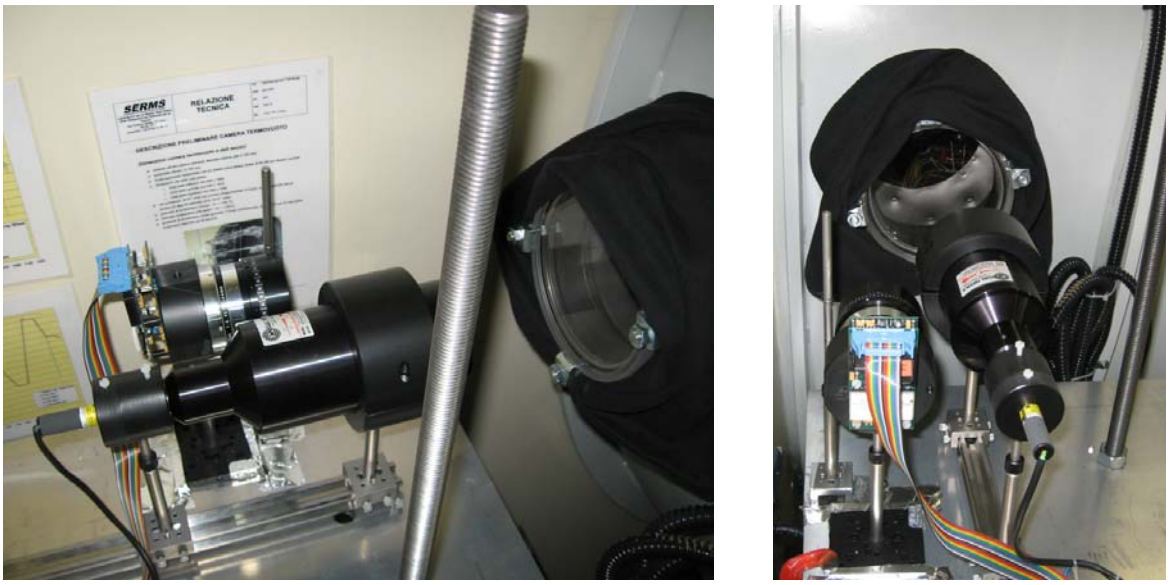

FIGURE 37 - EXTERNAL LASER AND CCD

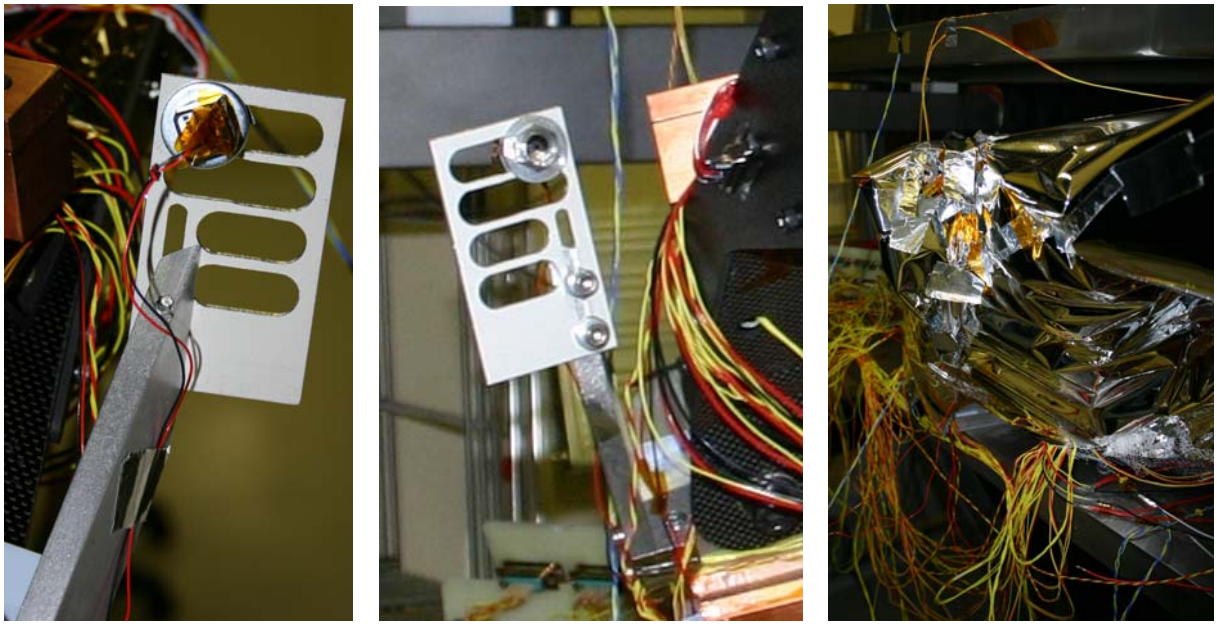

FIGURE 38 - INTERNAL LASER

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TEST GRAPHS

All the control and thermal parameters in the TVC have been continuously monitored and recorded during the test. The AST temperatures have been continuously monitored in 38 locations and their values recorded during the whole test period.

All the deformation data in the TVC have been continuously monitored and recorded during the test in 12 locations, with except of three periods: during the Worst Hot Stabilization phase, during and before the Worst Cold Stabilization phase.

In this section, the graphs summarizing the temporal evolution of all measured quantities during the whole test period are reported.

A more detailed set of graphs has been also produced for the evacuation phase and the test sub-phases as defined beforehand in the test summary section. These graphs have been reported in Annex 01 to Annex 11 to this report.

Hereby the S.E.R.M.S. guarantees that:

- the handling of the test data has been done only by qualified members of the S.E.R.M.S staff.

- all graphs presented in this report and its annex are a truthful representation of the recorded data and have been solely produced by the S.E.R.M.S. engineer in charge of the test.

The complete set of recorded data can be provided on customer request.

More detailed graphs relative to specific measurements can be produced on customer request.

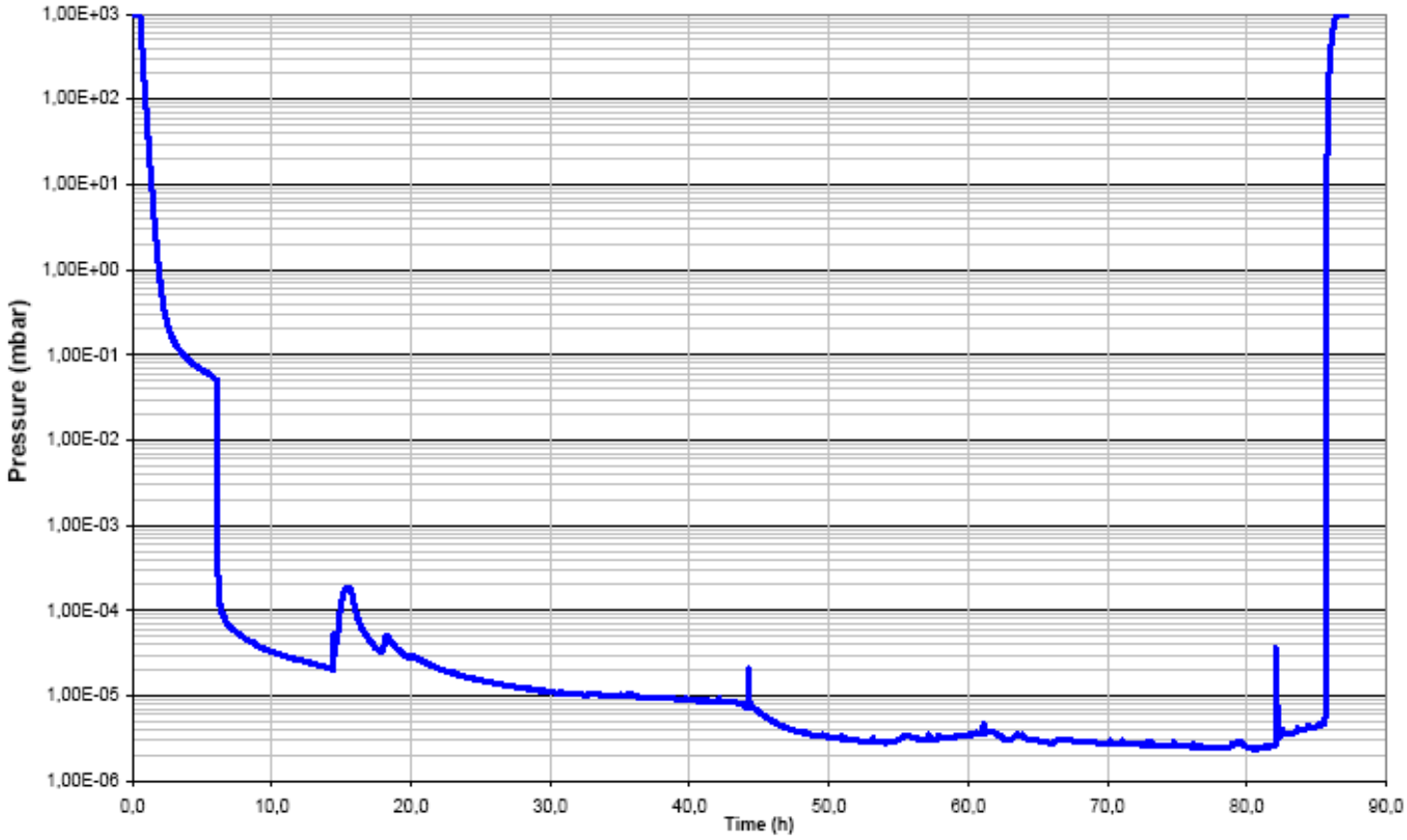
1,00E+03
1,00E+02
1,00E+01
1,00E+00
1,00E-01
1,00E-02
1,00E-03
1,00E-04
1,00E-05
1,00E-06
Pressure (mbar)
0,0
10,0
20,0
30,0
40,0
50,0
60,0
70,0
80,0
90,0
Time (h)

FIGURE 39 – PRESSURE PROFILE OF THE TEST.

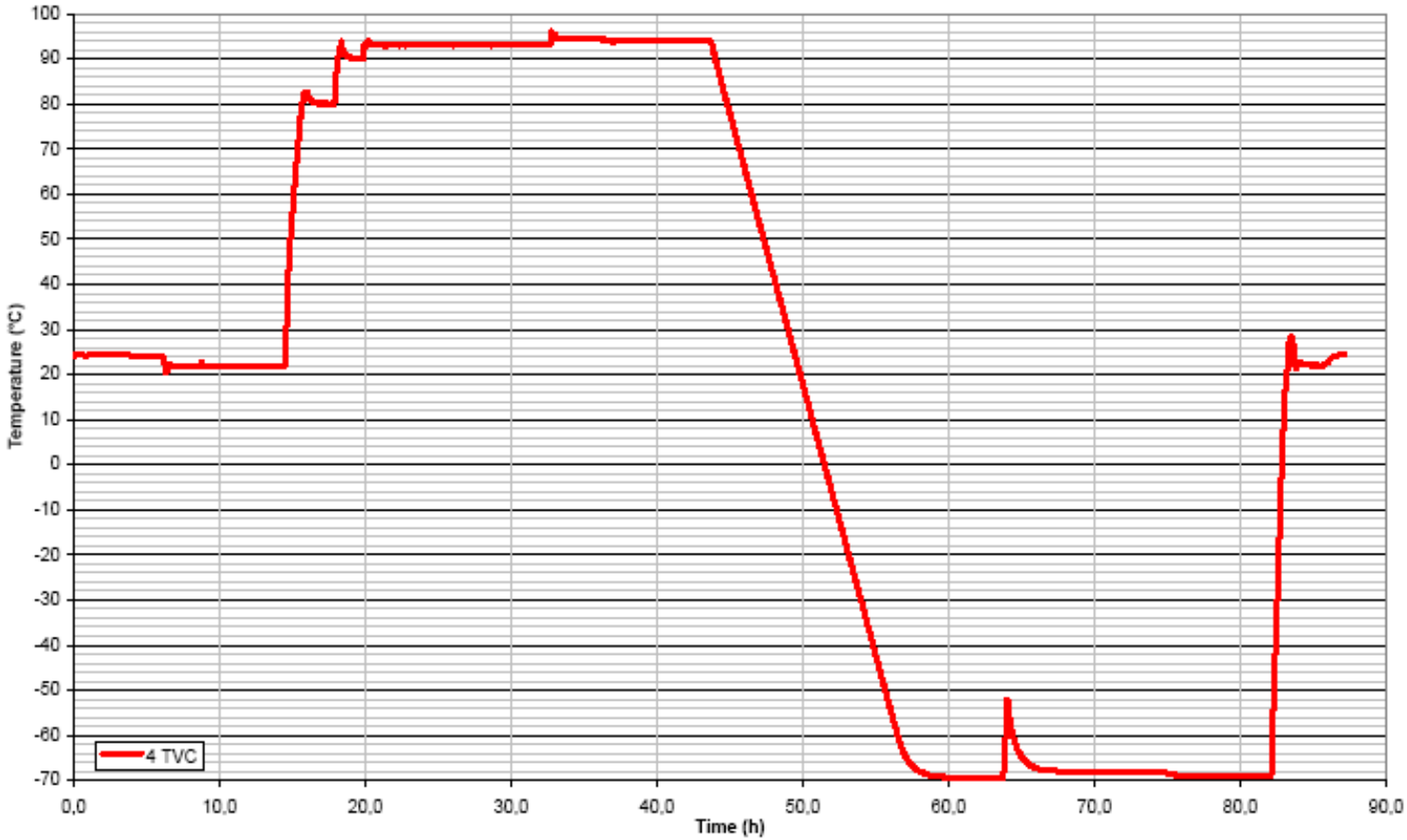
Temperature (°C)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
0,0
10,0
20,0
30,0
40,0
50,0
60,0
70,0
80,0
90,0
Time (h)
4 TVC

FIGURE 40 – SHROUD TEMPERATURE PROFILE.

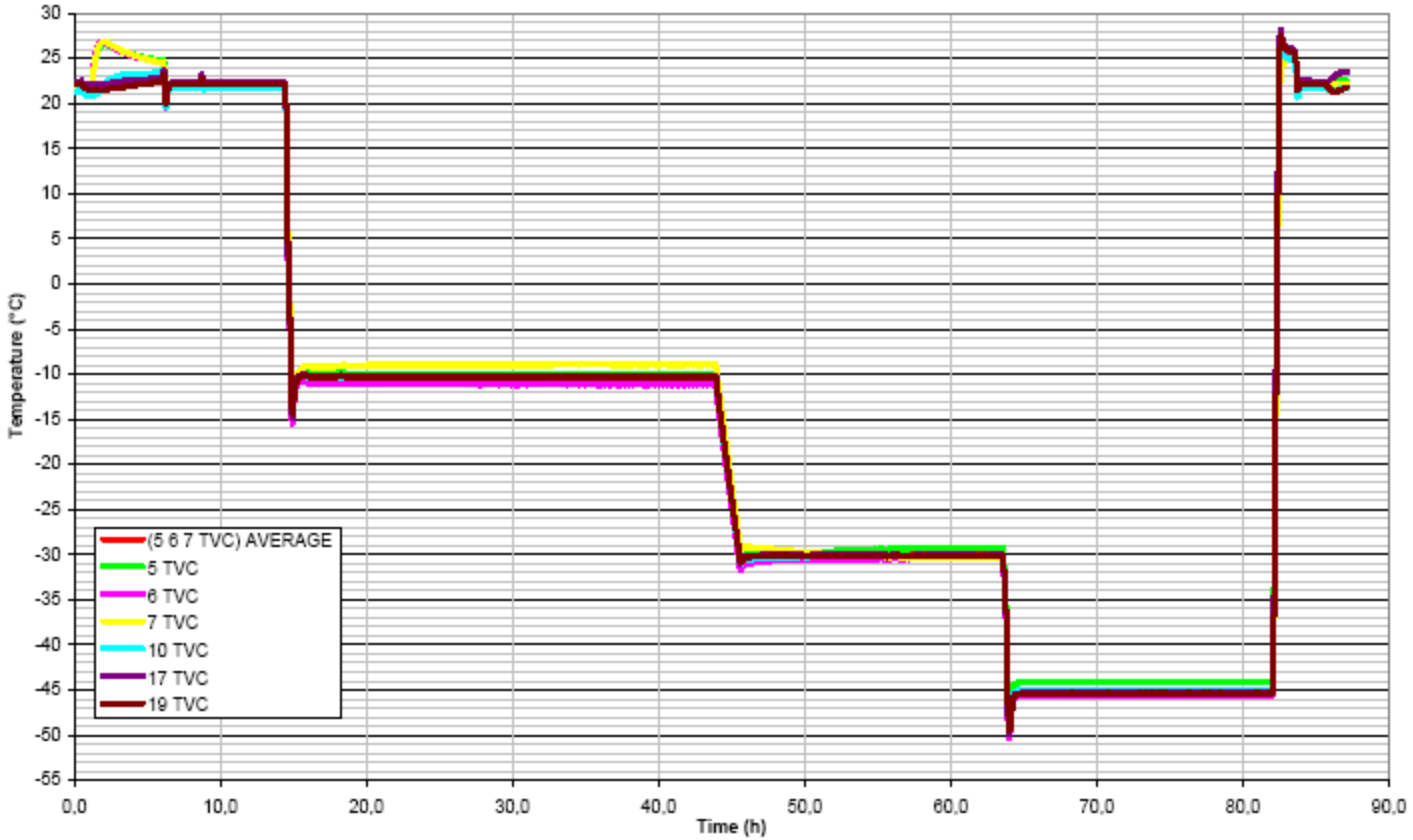

FIGURE 41 – COLD PLATES TEMPERATURE PROFILE.

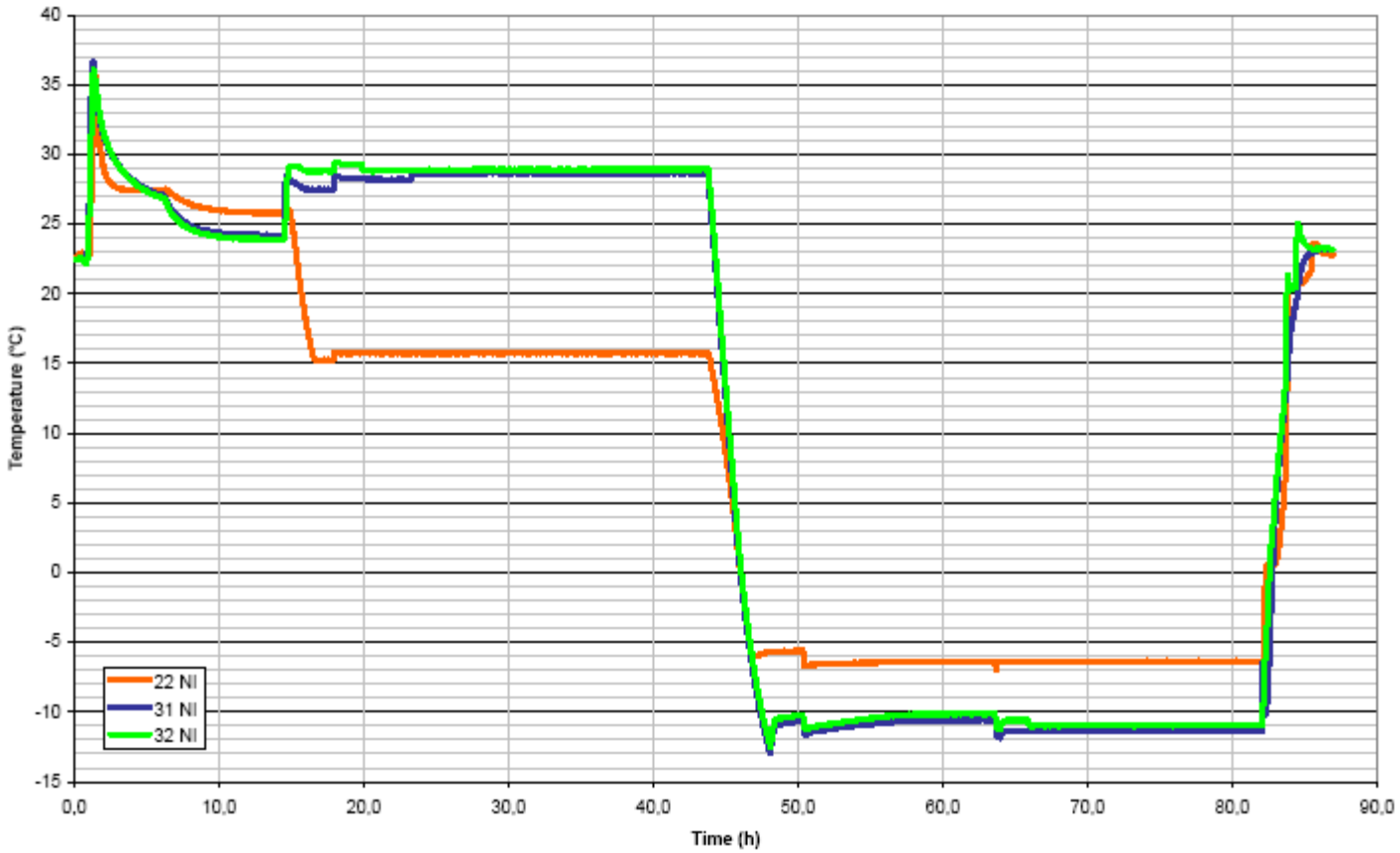
Temperature (°C)
Time (h)
22 NI
31 NI
32 NI
40
35
30
25
20
15
10
5
0
-5
-10
-15
0,0
10,0
20,0
30,0
40,0
50,0
60,0
70,0
80,0
90,0

FIGURE 42 – TEMPERATURE REFERENCE POINTS (CONDUCTIVE INTERFACES) PROFILE.

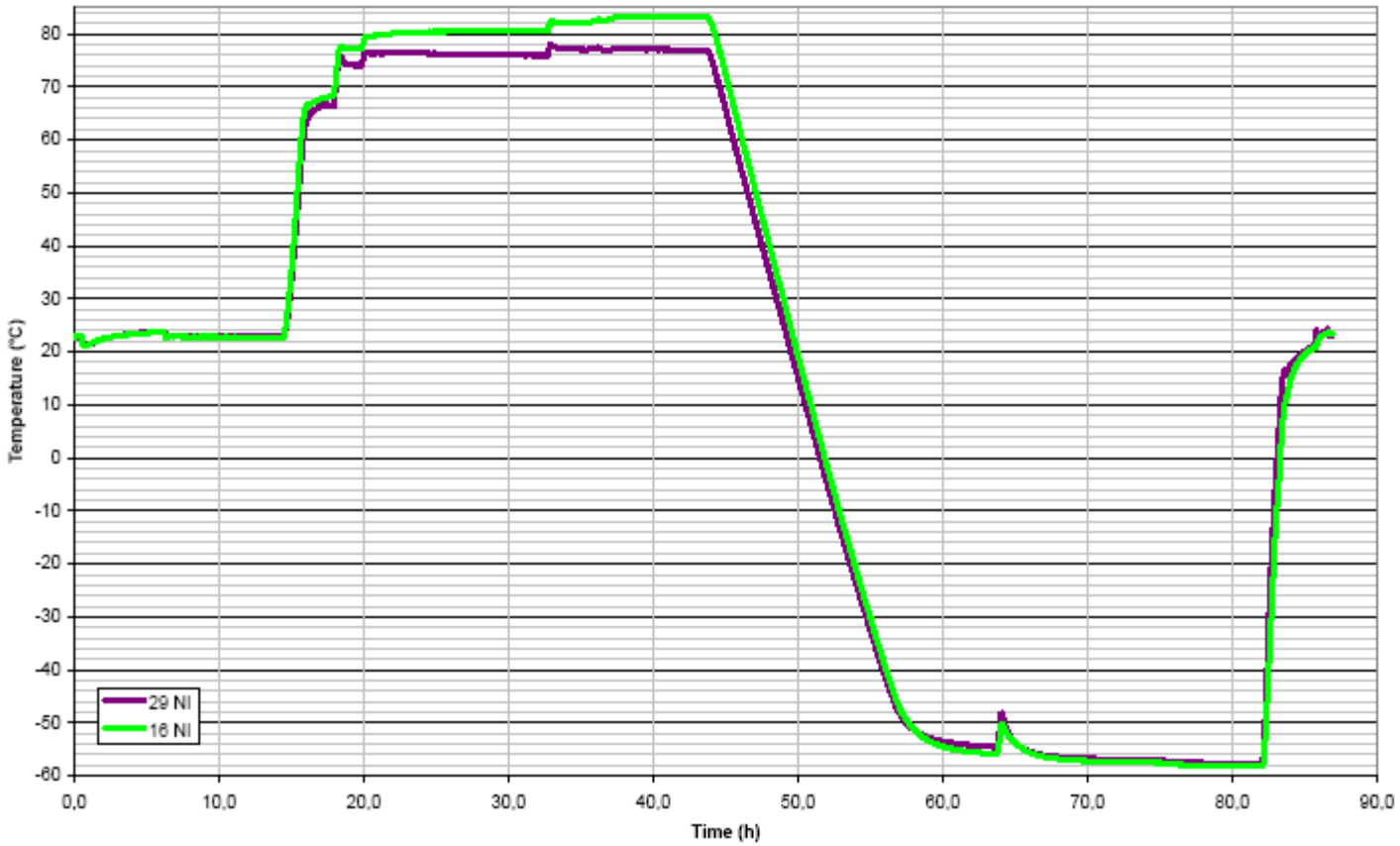
Temperature (°C)
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
0,0
10,0
20,0
30,0
40,0
50,0
60,0
70,0
80,0
90,0
Time (h)
29 NI
16 NI

FIGURE 43 – TEMPERATURE REFERENCE POINTS (RADIATIVE INTERFACES) PROFILE.

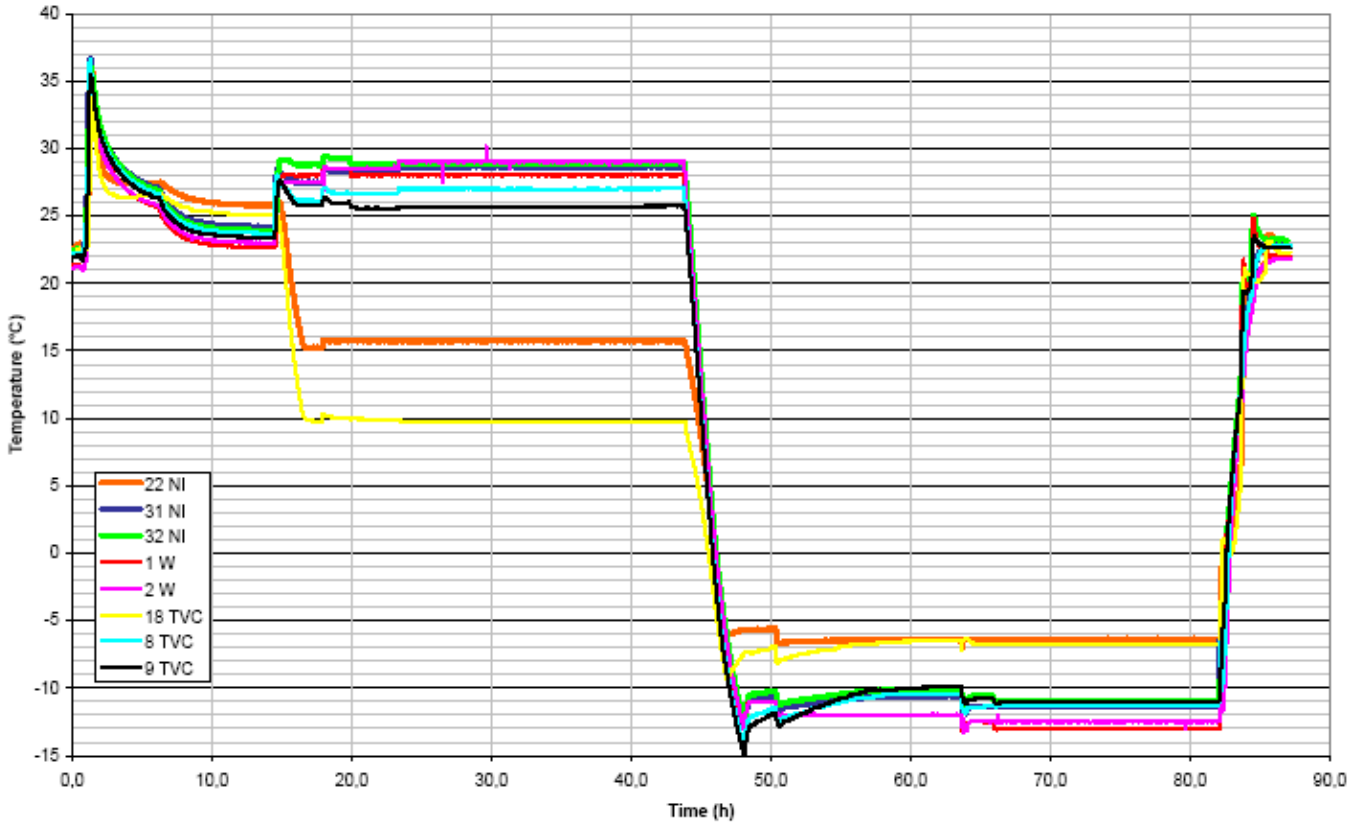

FIGURE 44 – CONDUCTIVE INTERFACES (EXTERNAL) SENSORS TEMPERATURE PROFILE.

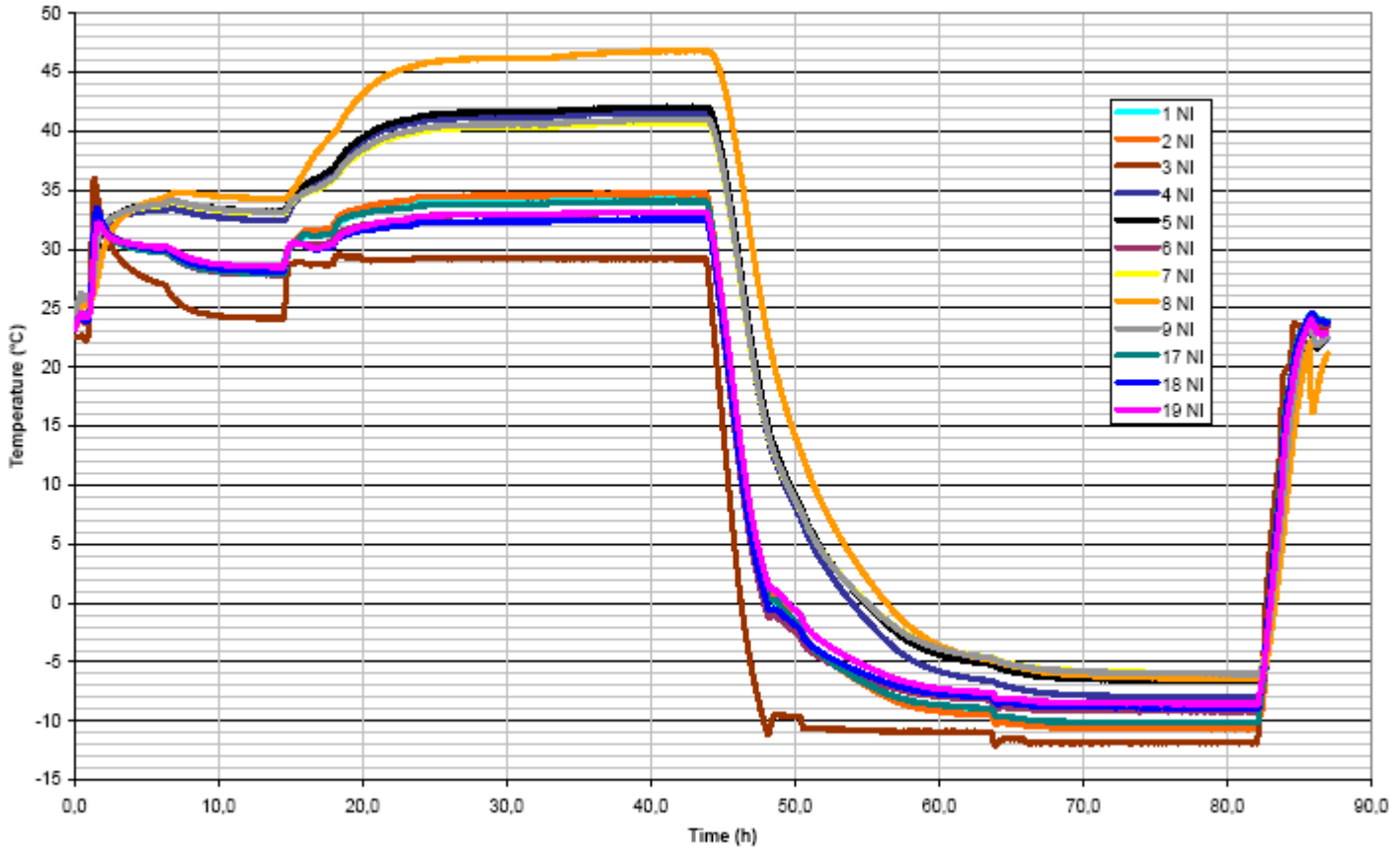

FIGURE 45 – AST COMPOSITE STRUCTURE (EXTERNAL) SENSORS TEMPERATURE PROFILE.

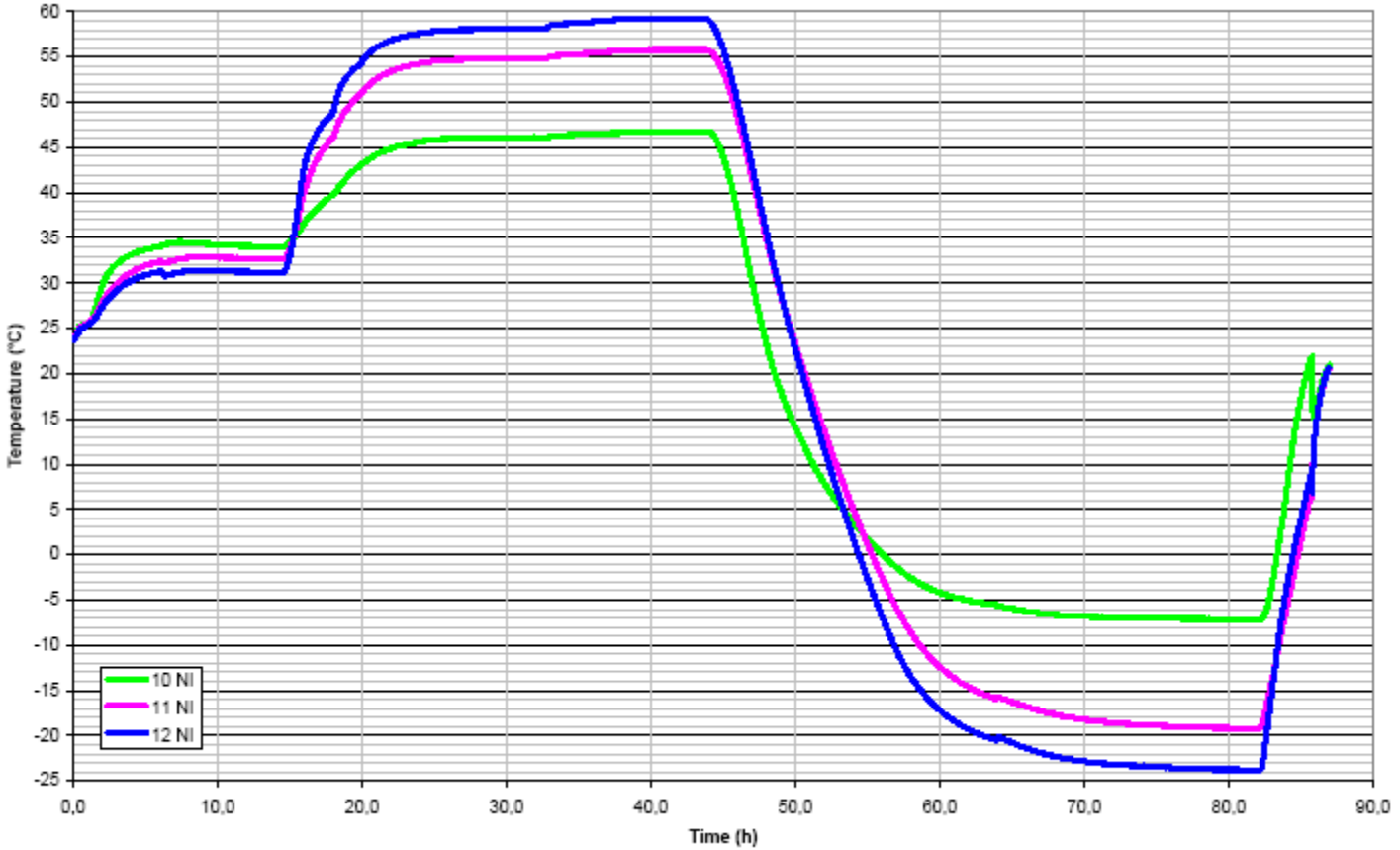

FIGURE 46 – LENS (EXTERNAL) SENSORS TEMPERATURE PROFILE.

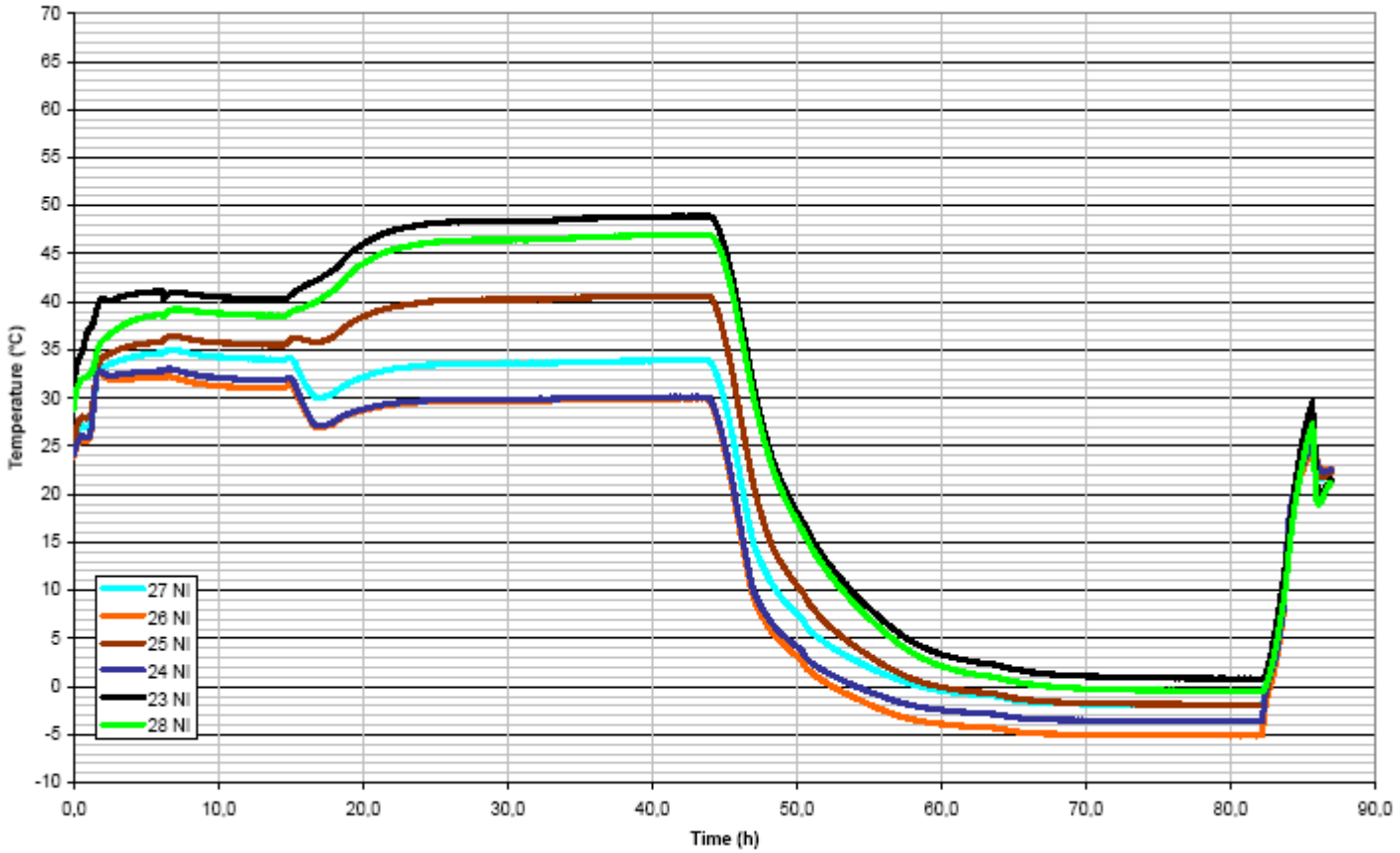

FIGURE 47 – ELECTRONICS (INTERNAL) SENSORS TEMPERATURE PROFILE.

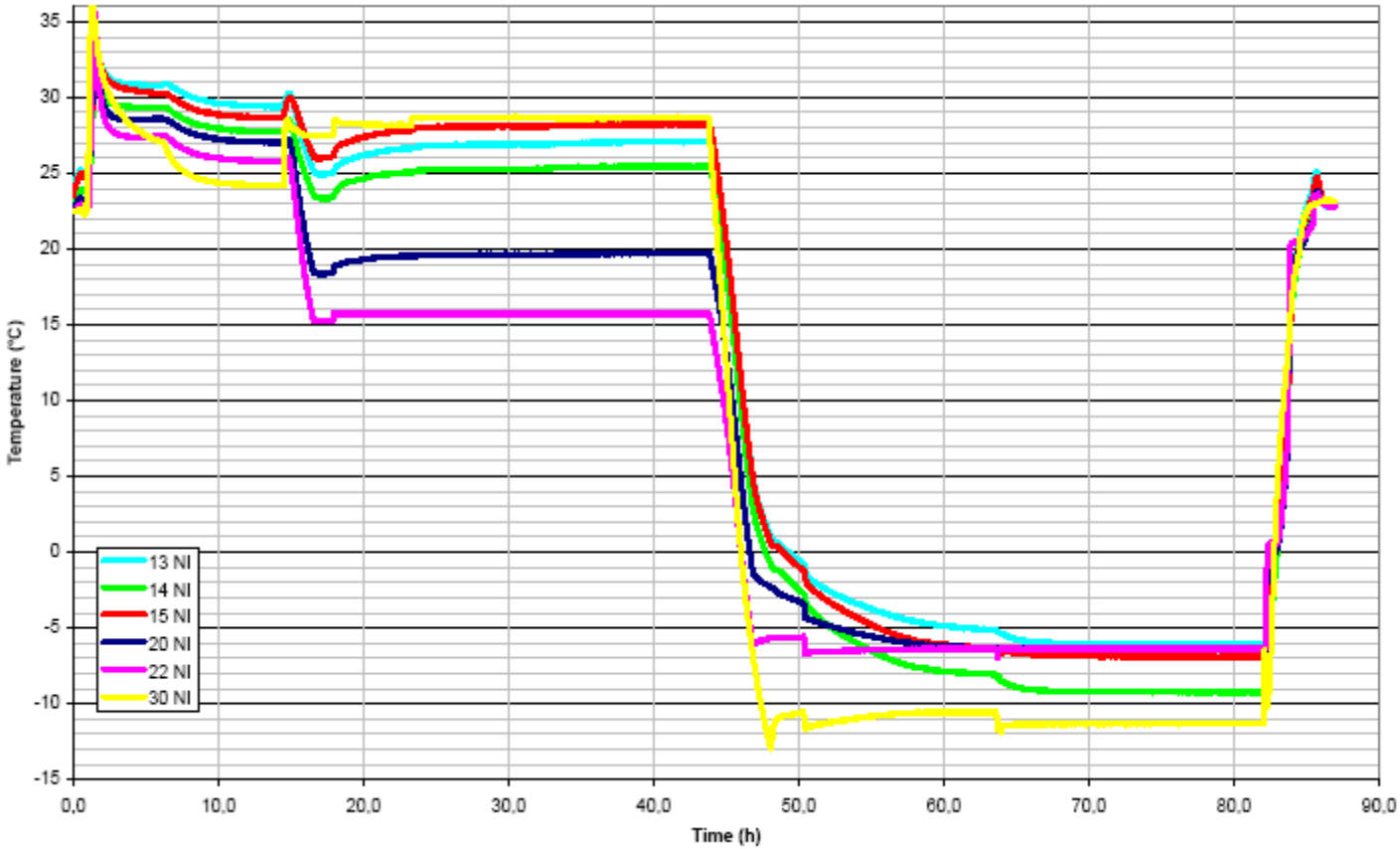

FIGURE 48 – COPPER THERMAL ARM (EXTERNAL) SENSORS TEMPERATURE PROFILE.

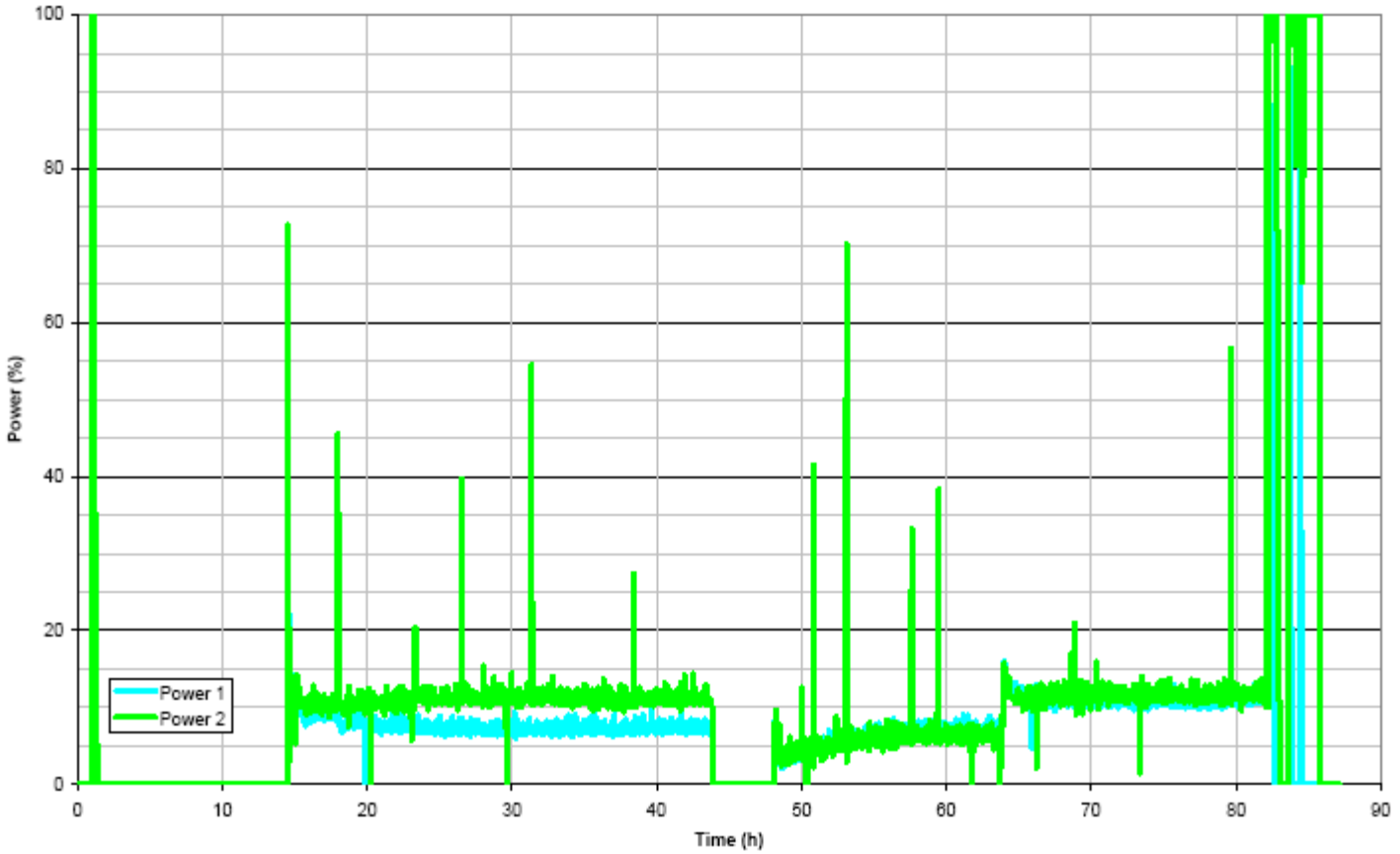

FIGURE 49 - POWER PROFILE (ON TRACKER INTERFACES HEATERS)

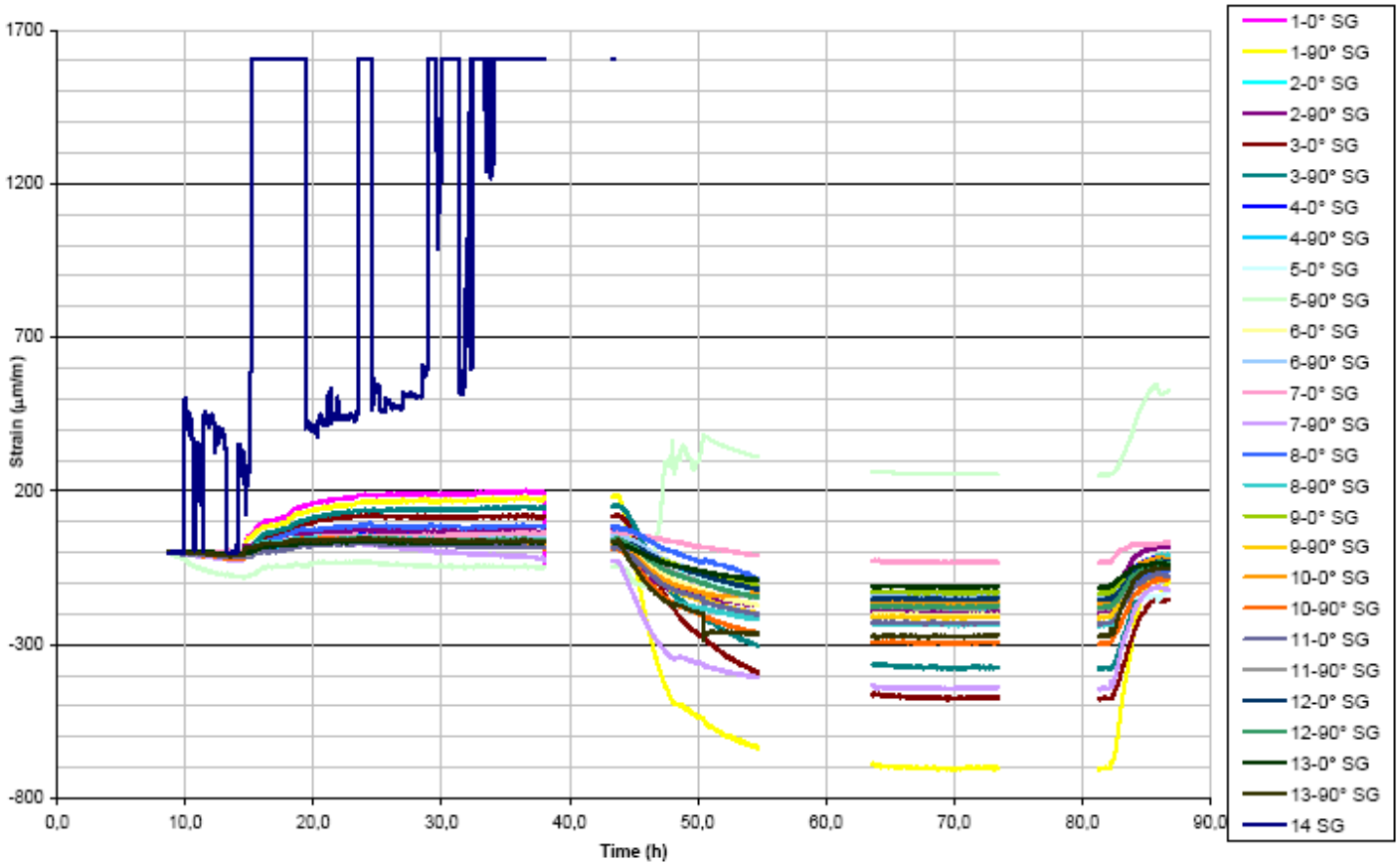

FIGURE 50 – ALL SENSORS STRAIN PROFILE.

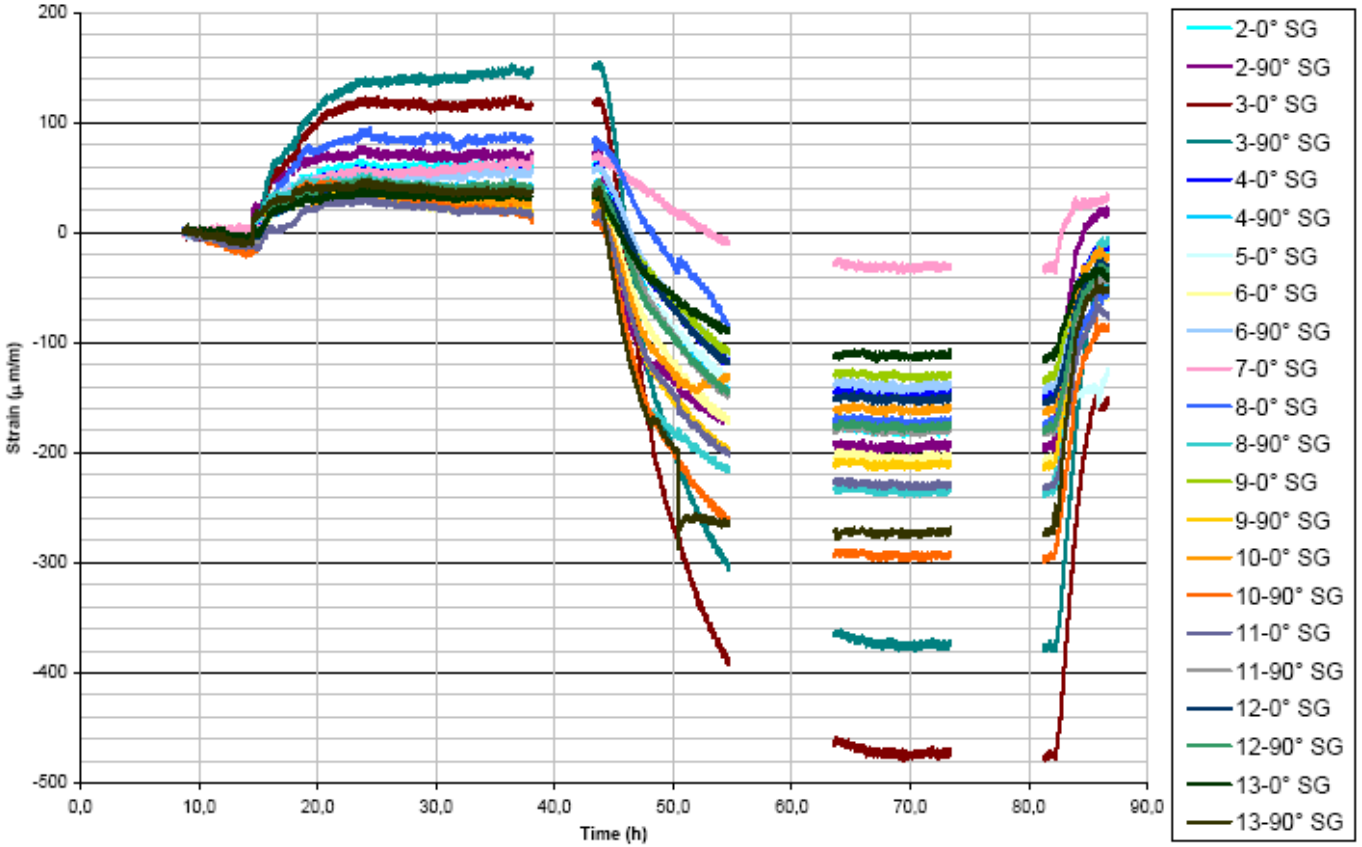

FIGURE 51 – VALID SENSORS STRAIN PROFILE.

END OF DOCUMENT